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January 25, 🎕

Seismology

8905 Seismic Sources Trayel Times and Station Corrections for P-wayes at ESEISMIC DISTANCES M. Driewonshi (Department of Geological Sciences ward University, Cambridge, Massachusetts 02138)

Arvard University, Cambridge, Hassachusetts C1138), and D. L. Anderson
Approximately J300 shallow focus earthquakes and 1000 seismic stations have been used in a study of P-mave travel-times and station residuals, including ariculal effects. The susmis were selected from a catalog containing 160,000 earthquakes and thuse having uniform distance and ariurable coverage were systematically relocated and used to refine P-wave travel tires and station corrections. Station corrections are provided for 994 seismic stations. The station corrections involve three terms: the static effect, and two toline terms with appropriate phase shifts. They entitle general consistency over broad geographic areas and, where coverage is dense, often show atomates to another. The cosine 24 terms appear to be due to upper monthe anisotropy and they correlate with the stress direction in the crust.

J. Geophys. Sec., Red. Paper 231666 - Georbys. Fes., Red, Paper 281666

6910 Seimic sources TOFAL-HAMET SPECTRA OF FOURTERY LARGE PARTHQUAKES P.G. Silver (Coclegical Research Division, Scrippe Losticution of Occanography, La Jolle, CA 92093),

T.R. Jordan Total-moment spectra $H_T(\psi) = \|[H(\omega)]\|/\epsilon T$, where $H_T(\psi) = H_T(\omega)\| \epsilon T$, where $H_T(\omega) = \epsilon T$, where $H_T(\omega) = \epsilon T$ is a computed for 14 large earth quakes recorded by the international Deployment of Accelerocaters (IDA) network using the scalar-moment retrieval notation proposed by Silver and Jorden [1982]. For each event we obtain estimates of My averaged over the ten disjunct, one-milliherts (mis) intervals in the lon-frequency band 1-11 MRs, typical IDA record mate from events with My 2 0.2 A (1 A = 10) dyna · cm) yield standard errors on the leaft systems that the companies.

ton computer, one-nilliberts (mile) interval in the low-frequency band 1-11 mile, typical 10th record ears from events with $\frac{1}{12} \approx 0.2 \times (1 \text{ A} = 10^{17} \text{ dyns} - cm)$ yield standard errors on the 1-mile averages that are generally less than 30t. Our multiple-band cellmans of Hy are usually consistent with comparable single-band values found by other investigators. From the total-members generally spectra we derive the zero-frequency (scatic) moment apactra we derive the zero-frequency (scatic) moment of 1 My(0) and the observations of the source duration of the moment-rate tempor, assumed to be the same for all components. The parameter [a formally depends on the second-degree temporal, spetial, and mixed spetial-temporal membes of mestended source, but calculations with realistic source generative indicate that the second temporal membes of mestended source, but calculations with realistic source generative indicate that the second interportation of Tc strictly in terms of the second temporal membes leads to very little error. A plot of Tc squints if shows considerable scatters cover wents in significantly above the suptrical scating curve of Kanasori and Given [1981] ("slow sarthquakes") and some below ("fast carthquakes"). Examples of the former include all three desp-focus events ensigned here, as well as the 1990 Godwshie and 1951 Feru-Solivia desp-focus serrhquakes, whose total-moment apactrs are calculated from the secent-tensor solutions of Gilbert and Orievocake (1975). As areasor in the lafert of to have are relatively shellow spetial course further to infere to the accession intosphyre. Three other large earthquakes. Tough 6/22/77; Nr = 23 i 2\h), which is infered to have are relatively shellow spetial course further to be accessed by the hospital course for the upper, more during larger values of Tc. The sferencels of hoth the Toughes, which along the partial decreases, twents busher. Temporables of the depth of the popular forcis and further course integrable suggest the security of the s The second se

6900 Salamic Sources Source time and scaling relations of large SOURCE TIME AND SCALING RELATIONS OF LARGE EARTHQUAKES
Muneyoshi Furusoto (Department of Earth Sciences Nagoys University. Chikusa. Nagoys 464. Japan: and Ichiro Nakanishi
Source time is a kinematic fault parameter corresponding to the duration of coismic source time function and is scourately determined from phases of long-period surfece waves. Source times are determined for 68 great and large earthquakes during the last three decodes. Scaling relations manes source times, aclassic moment, and fault dimension is proportional to source time. Source times for source time, and fault dimension is proportional to source time. Source times for low-angle thrust surfaces along desp-see treaches are found to be longer than those of such other types of earthquakes as introduced and deep shooks. They are also statisficantly longer than the rupture times expected from a Haskell model, suggesting that there exists generally an introductory stage of the rupture propagation. (source time, scaling relation, source parameter)

J. Geophys. Res., Red, Paper 281878

J. Geophys. Rem., Red, Paper 281878

6950 Seissic sources

6930 Seismic sources

FOCAL MENIATIONS AND LOCATIONS OF MATERIOGRANES IN

THE VICINITY OF THE 1975 EALAPANA RAETHQUARY
AFTERENCE ZORE 1970-1979; IMPLICATIONS FOR TECTORIGO OF THE SOUTH FLAME OF KILANDA VOCCARD,
INLAND OF HAMAIT

R. S. Crosson (Gasphysics Frogram, University of
Washington, Seattle, Washington 98195), E. T.

FRAG (D.S. Geological Survey, Characte Volumes
Observatory, Vancouver, Mashington 98651 and Geophysics Frogram, University of Washington, Seattle, Vashington 98195)

The Hovember 29, 1975, Ealapana earthquake of
magnitude 7:1 on the south flame of Kilanna Volcaso, Hawaii, represents a major rift cactomic
event. The aerthquake resulted from movement on
a massiy boritoutal fault plane, with the cruetal
block seath of Kilanna's eart rift none moving
south-southeastward up to several meters. Wellrecorded earthquakes os the south flank of
Kilanes from 1970 tq 1979 were earlysed and focal
wethenisms datermined to obtain a better understanding of the details of south flank testonics.
Included are a large number of serthquake from
the afterphock sequence of the 1975 marthquake,
hypocenture are distributed in a subplasar sone
that disp 2° to 3° to the west at a depth of
shoot 8-9 hm depth. This distribution coincides
with a portion of the slap place of the Kalapana
warthquake and it consistent with the action of
these slip plane occurring in a weak layer at the
top of the old occasing trate. Foreir medianisms
are 'mistrably countant throughout this cime
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Jack Oliver (Department of Geological Sciences, Corsell University, Ithaca, NY 18853), Fraductic Gook, and Larry Recom

This in a speculative paper on the continental crest, amice frontier of mulern earth science. Science relaction practiling data from the CCCOMP project, copied with athor kinds of geophysical and geological observations, nugapat mass from humapatives on the crust. For complete, there is evidence for great differences within the basement at a single site and from excess within the basement at a single site and from excess within the basement at a single site and from excess within the basement at a single site and from excess there is no humapative. There are not necessary to the crust is sell areas. There is, heaven't the puzziting and rather of home accurrence of limited zones of parallel, though at always flat, lavared features at various depths is created assemble states and the crust. Are the corresponding rocks accurately is detected. Are the corresponding rocks intrusions? Or highly deformed secretal sector? There is a vidence for large-scale thrusting and related features that members the thrusting from the thrusting process and remain there for long periods with a vertury of possible rhealings in the crust by the thrusting process and remain there for long periods with a vertury of possible rhealings and former occasion consequences. In some places the modern Moho and disconsequences. In some places the modern Moho and disconsequences.

testonics). J. Geophys. Res., Red, Paper 281808

1999 General (Sonic logging)
IN SITU STUDIES OF VELOCITY IF FRACTURED
CRISTALLING ROCKS
D. Noos (U.B. Geological Survey, 343 Middlatistd
Road, Manlo Park, CA. 94025 and Stanford
University), H. B. Zoback
A Study of the effects of macroscopic fractured
on P- and B-wave velocities has been conducted in
four wells drilled in grantic rock to depths
between D.5 and 1.2 km. The effect of macroscopic
fracturents is to demonstrate both V and V and between 0.6 and 1.2 km. The effect or measure fractures is to decrease both V_p and V_p and increase V_p/V_p. In wells with a relatively low density of meroscopic fractures, the is size velocity is minimate to that of ascurated one masples under confining presents in the laboratory, and there is a clear correlation between measure the manuscraped fractures and atominus!; samples under confining presents in the leaves tory, and there is a tiper correlation between somes with macroscopic fractures and anomalously low velocities. In wells with mestrous macro-scopic fractures, the in size velocity is lower from that of intent samples under pressure, and there is a correlation between the rate at which in acts velocity increases with depth and the rate at which the velocity of imbrarcory samples increases with pressure. Differences in is alto pressure, the seminary of imbrarcory samples increases with pressure. Differences in is alto pressure, thus amphasially the importance of recovery the samples of the protection and microcracks or respectively. In one highly fractured well the in size p-wave velocity in constitution of free 10 Ha to 20 MHz; this suggests that the macrocracks of read to the constitution of the protection of

J. Geophys. Res., Eed. Feper 281807

Walter B. Langbein: 1907-1982



Walter B. Langbein was born in Newark, New Jersey, on October 17, 1907, and died at his home in Arlington, Virginia, on December 10, 1982. For 33 years he carried on a distinguished career in hydrologic research with the U.S. Geological Survey—very much in the public interest.

Langbein graduated from Cooper Union in 1931 with a bachelor's degree in civil engineering. While attending classes in the evening, he worked for the Rosolf Construction Company, beginning as a rodman on a surveying team. At that time the company was engaged by the city of New York to enlarge the subway along 8th Avenue. Between 1231d Street and 124th Street, excavation was suspended a short time after it was begun because difficulties were encountered in lowering the groundwater levels with pumps. As the junior member of the engineering staff, Langbein was given the task of measuring and recording the distance of the water level

below a reference mark—a task he later recalled as being his 'introduction' to hydrolo-

gy. In 1935, Langbein left the Rosoff Construction Company to take a position with USGS in Albany, New York. He had enjoyed his work with Rosoff and felt he had learned much, although he never understood why Arthur H. Diamant, vice-president of the company, kept urging him to learn about 'least squares'—especially since none of the work called for such knowledge. He began his hydrologic career in the then

traditional manner; by stream gaging and making slope-area measurements of Hoods. The professional atmosphere of the work in Albany made a lasting impression on Langbein: There was no time clock to punch, attention was paid to details, responsibilities were delegated, and one was encouraged to learn. Throughout his career, Langbein sought to provide this atmosphere for others.

It was the hydrology of floods and their social impacts that attracted Langbein's scientific attention. He wrote extensively on the subject, particularly after he transferred to Washington, D.C. in 1939. His technical papers, as well as those written for a more general audience, on the probabilities of floods and the relation of those probabilities to social risks within the flood plains, and his book, Floods, coauthored with W. G. Hoyt, directly contributed to the development of a federal position on flood insurance. That position was implemented by the 1968 National Flood Insurance Act (P.L. 90-448: August I,

During the late 1940's and early 1950's, Langbein was closely associated with the Soil and Moisture Conservation Program of the Interior Department. He was particularly interested in the effects of grazing and land treatment on soil moisture and runoff. While associated with that program, he devised a 'tipping-bucket' rain gage recorder before recording rain gages became available. It was during this time that he also became interest ed, through Earl Harbeck, in measuring evaporation and transpiration.

Langbein recognized that the runoff from drainage basins and the drawdown of aquifers could not be explained strictly in terms of climatic factors: an account of land use was no less important. To provide a rational basis for quantitatively accounting for land use, he collaborated with Luna B. Leopold in study-ing the carrying capacities of drainage basins in terms of their geomorphologic features. Together, they gave the first statistical explanations of R. E. Horton's 'laws' of stream orders and of the meandering of rivers. Whatever else might be said about this work (carried out in the early 1960's), it gave meaning to hydrology on a large regional and temporal scale. A closer look at this work would do much to further dispell the notion that 'each river is a law unto itself,' a notion that can be traced in the hydrologic literature back to the

turn of the century. From the time he recorded his first 'hydrologic' measurements while working on the construction of the New York City subway system, he never lost interest in matters pertaining to the collection of hydrologic data. In fact, his interest in data collection increased as a younger generation was intro-duced to hydrology through computer simulation rather than through the gaging of streams and wells. He did not question the merit of this newer introduction, but he was concerned that the quality of the data not de-

His book, Water Facts for the Nation's Future, coauthored with W. G. Hoyt in 1959, drew attention to how important systematic collec-tion of data is to development of water resource systems. The book was the motivation for a comprehensive approach to data collec-tion, now generally referred to as network design, in explicit terms of the economic worth of data. Following the Ottawa meeting of the International Association of Hydrologic Sciences in 1960, network design became f prime interest in hydrologic research in addressing questions about the relative importance of parameter estimation and choice of model in describing the stochastic proper ties of hydrologic processes.

Together with Luna B. Leopold and Ray Nace, he was instrumental in laying the foundation for the International Hydrologic Decade (1965-1975). His active participation did much to assure the success of the 'program' in furthering international exchange in hydrologic research, in promoting a more structured approach to national data collection programs through network design, and in providing a more comprehensive description of the global water balance.

In recognition of his scientific contributions he was the recipient of many awards, among them the Bowie Medal (1969) and the Horton Medal (1976) from the American Geophysical Union, the J. C. Stevens Award (1963, with Thomas Maddock, Jr.) from the American Society of Civil Engineers, the Distinguished Service Award (1959) from the Department of the Interior, and the Warren Prize (1976) from the National Academy of Sciences. A year after he retired in 1969, he was elected a member of the Academy. And in November 1982, he and Professor Korzum of the Soviet Union were the corecipients of the International Prize in Hydrology for 1982, awarded by the International Association of Hydrological Sciences.

Many of us have lost a friend and colleague, one who so often and willingly gave us his technical help and wise counsel. He learned and then taught us much about least squares.' We will miss him. Younger generations will make his acquaintance, for his place in the annuls of hydrology is secure.

In his honor, a memorial fund for the study of water resources has been established at Cooper Union.

This obituary was written by Nick Matalas, a hydrologist in the Water Resources Division of the U.S. Geological Survey in Reston, Va. He wishes to express his appreciation for material on Langbein's early work which was provided by Rose Langbein and Charles C. McDonald. (Photograph courtesy of the U.S. Geological Survey.)

Yews

Wet December for **Nation's Streams**

Much of the nation experienced a very wei December, with 60% of the key index gaging stations in parts of 23 states reporting flows within the highest 25% of record, and record high December flows were set on key index stations in at least 14 states, according to the

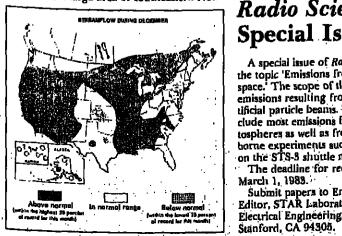
U.S. Geological Survey,
As a further indication of the wet Decemher conditions, USGS hydrologists said that the combined flow of the nation's 'Big Five' rivers (Mississippi, St. Lawrence, Columbia, Ohio, and Missouri), which was boosted by runoff from rain-swollen streams, ended the year on a wet note, averaging 1203 billion gallons a day (bgd) during December, almost twice the average for the month and the seventh straight month that flows have been above average.

The intense flooding that affected much of the Mississippi and Missouri river basins boosted streamflow on those rivers to their highest December flows in 55 years of record. Flow of the Missouri River at Hermann, Mo., averaged 117 bgd, 347% above average for December. On the Mississippi River near Vicksburg, Miss., December flow averaged 741 bgd, 142% above average. In the areas heaviest hit by the flooding,

streamflow runoff at many sites set new record highs and the recurrence intervals of flooding in parts of Arkansas, Illinois, Louisiana, and Missouri exceeded 100 years. This means that on the long-term average, a flood of this magnitude is not expected to occur uian once in 100 years.

Indicative of the record-high December discharge in the Midwest was the flow of the Mississippi River at Keokuk, Iowa, which averaged 81.2 bgd during December, the high-est December average flow in more than 100 years of continuous records at that site.

In contrast to the many record high streamflows, key index gaging stations in parts of Kansas, Texas, South Carolina, Wisconsin, and a large area of southeastern New



York reported well-below average stream-flow—within the lowest 25% of record. Also in the East, streamflow conditions in the Del-aware River basin remain extremely low and drought emergency measures are cominging. Reservoir levels in the basin are still only about 39% of their full capacity.

Swiss NSF **Fellowships**

The Swiss National Science Foundation (SNSF) annually awards a few international posteloctoral fellowships for American scientists involved in earth, astronomical, atmospheric, mathematical, physical, or engineering sciences to work in Switzerland. Recipients must be under 36 years of age at the beginning of the fellowship tenure.

Applications for fellowships that begin between September 1, 1983, and April 1, 1984, must be completed and returned to the U.S. National Science Foundation (NSF) by February 28, 1983. NSF will then transmit the applications to the Swiss National Science Foundation. Awards usually are announced by

SNSF in July.

For application forms and additional information of the state of the mation, contact Warren Thompson, Division of International Programs, National Science Foundation, 1800 C Street, N.W., Washington, DC 20550 (telephone: 202-357-9700). Subject to availability of funds, a few fel-

lowships will also be awarded for tenure being between September 1, 1984, and it 1, 1985. Selection procedures are likely to change, however. Interested persons should contact NSF. Applications for thes fellowships will be due at NSF by October 3,

Radio Science Special Issue

A special issue of Radio Science will focus on the topic 'Emissions from particle beams in space. The scope of the issue will include emissions resulting from both natural and artificial particle beams. Thus topics will include most emissions from planetary magnetospheres as well as from controlled spaceborne experiments such as those performed on the STS-3 shuttle mission.

The deadline for receipt of papers is March 1, 1983. Submit papers to Erwin Schmerling, Guest Editor, STAR Laboratory/SEL, Department of

Electrical Engineering, Stanford University,

<u>Meetinas</u> 1982 AGU Fall and ASLO Winter **Meeting Report**







Poster sessions, a growing part of the AGU meetings, are an attractive way for scientists to display

There were more than 2400 papers presented, with more than 3250 attendees registered at the 1982 Fall Meeting in San Francisco. This was the largest AGU meeting ever. Changes to the program and additional, late and revised abstracts are printed below.

Papers Not Presented

A11A-14, R. L. Gardner et al.; A11A-15, J. W. Erler et al.; A31A-01, W. H. Pollock et al.; G32A-06, P. F; MacDoran; G32A-11, F. Mulargia et al.; GP52A-02; B. G. Thompson; GP82A-04, J. Helgason; H12A-03, L. Duckstein; H21A-17, D. R. Wiesnet et al.; H51A-03, D. H, Burn; H41B-04, D. C. Wilkin; H51A-05, G. Padmanabhan; H51A-09, K. L. Verdin.

LO11A-13, G. T. Taylor; LO11B-03, D. W. Krempin; LO11B-08, W. G. Harrison; LO12B-10, J. M. Morrell et al.; LO21A-12, A. V. Mendoz; LO31B-02, D. Dogge; LO31B-14, J. R. Robertson; LO31C-02, D. Waslenchuk and R. Zajac; LO31C-03, M. C. Newman et al.; LO31C-09, A. W. Herman; LOSIG-10, P. R. Haberstroh and S. I. Ahnied; LO31C-12, N. T. Sterman and B. B. Prezelin; LOSIC-13, R. R. Cohen; LOSIC-17, H. A. Vanderploeg; LO31C-22, G. L. Tagh-oon; LO42A-09, W. K. W. Li; LO52A-12,

A. W. Groeger et al.; LO52A-11, R. L. Whit-

man; LO52A-12, A. W. Groeger. Ol 1C-02, N. E. Huang et al.; Ol 1C-13, F. Gonzalez; Ol 1C-14, M. R. Mulhern; Ol 2A-09, P. Ripa; O12C-02, R. W. MacDonald; O12D-08, D. Nof; O12D-14, P. F. Spain; O12D-15, H. Bryden; O12D-21, A. D. Kirwan et al.; 021A-06, C. Paola; O21C-04, R. H. Fillon; O21D-10, L. Magaard et al.; O21E-03, W. C. Graustein; O22B-06, J-Y Zhou; O22C-05, M. A. Kaminsky; O22D-05, E. J. Lindstrom; O22D-12, R. G. Peterson; O32C-11, F. S. Hotchkiss; O32C-16, C. Sancetta; O32C-19, J. G. Patterson et al.; O41B-07, G. S. Malari, O41B-07, G. Malari, O41B-07, Otto: O520-19, J. C. Patterson et al.; O41B-07, C. S. Nelson; O41B-10, R. Iturriaga et al.; O41B-11, J. J. Simpson; O41B-15, R. C. Dugdale and J. J. MacIsaac; O51C-30, J. Condela; O52B-06, S. Honjo; O12D-05, E. A. Kelley. P31A-10, A. 1. F. Stewart; P61A-6, F. C.

Michel, S52-01, J. Cipar and G. Market; S52A-04, D. R. Hutchinson; S62A-09, R. Butler; S72-11, J. A. Canas; S81B-09, P. Scott; S82A-08, J. R. Bowman; S82B-08, R. A. Davis and F. J. Mauk; SA12A-02, A. Dasgupta; SA21A-02, L. M. Duncan; SM12A-13, K. Bruning; SM12B-08, K. Wilhelm; SM32B-15, M. El-Raey; SM41A-02, S. Messick; SM41A-09, H. A. Garcia; SM51-07, H.M. Chang; SS4 I A-09, H. H. Sargent III.

Meetings (cont. on p.44)

The Oceanography Report
The focal point for physical, chinical, geological, and bio-

Associate Editor: Arnold L. Gordon, Lamont-Doherty Geological Observatory, Palisades, New York, 10964 (telephone 914/359-2000, ext. 325)

The Manganese Nodule Program

Michael L. Bender

Introduction

The Manganese Nodule Program (MANOP) began in 1977 with funding from the International Decade of Ocean Exploration (IDOE). It replaced an earlier IDOE program that was started in 1972 in part by Maurice Ewing, MANOP's view is that the composition and occurrence of nodules can he best understood in the context of the large variations in the rain rate of organic matter to the deep-sea floor and the variable sedimentary geochemistry of their environment Therefore, from the beginning much of MANOP's effort has been directed toward understanding the cycling of the biologically active elements-O2. C. nutrients, and trace metals—in the deep sea; in fact, this aspect

has itself become a primary goal of our work.

MANOP is studying manganese nodules and abyssal geochemistry at five varied North Pacific sites (Figure 1). The sites, in order of decreasing biological productivity in surface water, are site H, a hemipelagic sediment site in the Pamama Basin: site M, a metalliferous sediment site on 400,000 year old crust on the eastern side of the East Pacific Rise; site C, a calcareous ooze site at 1°N, underneath the equatorial upwelling zone; site S, a siliceous coze site, that is nearly a site of nondeposition, with a ~1 m thick cap of Quaternary aluminosilicate sediment overlying Miocene siliceous oozes; and site R, a red clay site north of Hawaii. Manganese nodules are present on the seafloor at sites H, S, and R.

The scope of MANOP is shown in the cartoon in Figure 2. The effort devoted to understand the cycling of bioactive elements includes determining the particulate flux to the seafloor, the benthic flux of dissolved chemicals across the sediment-water interface, and the burial rates of the bioactive elements. As part of this work, J. Dymond (Oregon State University) and A. Soutar (Scripps Institution of Oceanography) are deploying sediment trap arrays at each of the MANOP sites. The arrays are deployed for a year; and four trimonthly samples are collected from each trap so that seasonality in the particulate fluxes may be studied. Dymond is analyzing C. CaCO_J. Si, major elements, and trace metals in trap samples. W. Moore is analyzing U-scries radioisotopes to study trapping efficiency and scavenging rates of these elements. J. Ed-mond (MIT) is studying cleep water hydrog-

areous, S = siliceous, and R = red clay).

Fig. 1. Location of MANOP stricty sites (M = metalliferous, H = hemipelagic, C = cal-

raphy and distributions of trace metals at our sites. S. Emerson (University of Washington), and M. Bender and D. Heggie (University of Rhode Island) are studying pore water chemistry to understand the rates and mechanisms of organic matter oxidation on the seafloor and the compositions of pore fluids from which nodule bottoms may grow. The rates of sediment accumulation at each site are being determined by T.-L. Ku (University of Southern California) and D. Kadko (U.S.G.S., Menlo Park) using U-series dating. Rates of sediment bioturbation are being estimated by Ku and Kadko using Pb²¹⁰ and by K. Coch-

ran (Woods Hole Oceanographic Institution) using Th²³⁴ and Pu. Detailed studies of the marine geology are being done at each of the sites. Each site has been surveyed by Deep Tow (F. Spiess and P. Lonsdale, Scripps) for detailed bathymetry, bottom photography, bottom reflectance, and subbottom reflectors. The bottom reflectance studies, done with side-scan sonar, are particularly interesting, as they give a qualitative picture of nodule abundance variations on the seafloor. At sites S and H, W. Gardner and L. Sullivan (Lamont) have taken bottom photographs over a year-long period. At H. we photographed and surveyed the sealloor with Alvin in 1981. At all sites, R. Heath and M. Lyle (Oregon State University) have extensively studied the major and trace element composition of the sediments.

Studies of manganese nodules are aimed at understanding their growth rates and metal geochemistries. Dymond has studied the compositions of whole nodules as well as scrapings from tops and bottoms. P. Buseck and S. Furner (Arizona State University) are collaborating with MANOP, doing TEM studies of the crystallography of nodule minerals.

Moore (University of South Carolina) and Ku have made detailed studies of the uptake of U-series radioisotopes by nodules from seawater, pore water, and sediments. The most extensive effort has gone into determining growth rates of manganese nodules by Th²³⁰ dating, Pa²³¹ dating, and Be¹⁰ dating (the latter by T.-L. Ku of the University of Southern California and E. Nelson of Simon Fraser

The MANOP Bottom Lander, our largest single effort, is being constructed by R. Weiss (Scripps) to carry out in situ seafloor experiments bearing on many of the above areas. The Lander is a free vehicle with three box cores; it is designed for seafloor deployments of several months' duration, during which time microprocessor-controlled experiments may be run. During the deployments, turbulence within the boxes is maintained by circulating pumps of a new design, which have very low power requirements. The water within each chamber can be sampled up to 20 times during the course of the experiments. At the end of an experiment, scoops under

the boxes close and cores are thereby re-Two inaugural experiments are planned for the Lander: benthic flux measurements and radiotracer uptake experiments. In the benthic flux experiments, fluxes of O2, nutrients, C, alkalinity, and trace metals across the sediment-water interface will be determined from the rates of change of concentrations in the chamber water. In the radiotracer uptake experiments, radio-labeled metals are added to the chamber, and the distribution of spikes is subsequently determined in the chamber water (as a function of time) and in the sediments and pore water (as a function of depth). The results will give information about adsorption of trace metals by sediments and nodules, of bioturbation, and of irrigaMANOP Site H Results: Deep Water Cycling of Bioactive

Rather than try to cover our entire effort, this report will focus on the work at site 11. MANOP's most studied station. A brief comparison of results at other sites will follow. This discussion of site H will start where

MANOP started, with the Deep Tow work (Figure 3). The bottom shoals from a depth of 3650 m in the south to 3575 m in the north. The generally smooth rise is interrupted by a series of holes up to about 125 m deep near the center of the survey area. Nodule cover, based on Deep Tow photographs, decreases from about 12% of the scattoor in the south to 3-4% in the north. This smooth decrease is punctuated by the bare patches, remarkable areas up to 500 m wide from which manganese nodules are absent. The existence of these features was detected by the contrast between the intensity of side scan sonar reflections from nodule covered seafloor and bare patches; it has been confirmed by Deep Tow photography and DSRV Ahvin observations. The bare patches lie in the center of 2-3 m depressions but are not clearly distinguished from nodule-covered sediment by either sediment chemistry or pore water composition. At this point the origin of bare patches remains an important mystery.

MANOP site H underlies highly productive surface waters; therefore, we were not surprised when our Alvin work revealed that site H is an area of intense benthic biological activity. Anemones, brittle stars, shrimp, holothurians, echinoderms, and other animals are common on the seafloor. The site is crisscrossed with tracks, and more extensive deposits of disturbed sediment are common. These include sediment mounds, 'deltas,' and the fairy rings-moats about 0.5 m in diameter, with nodules in moats showing clear evidence of movement by organisms.

There is some evidence that this high organic matter flux drives rapid bioturbation of sediments. Bioturbation rates of 500— 1000 cm²/10³ yr (15-30 times typical pelagic values) were measured in one core by Huh and Ku from Th²³⁰, Pa²³¹, and Pb²¹⁰ distributions. On the other hand, in another core, Pb210 gave a rate of 30 cm2/103 yr [Kndko, 1981), as was modeling by Heath of the dis-tribution of solid phase diagenetic manganese profiles (in which modeling transport of dissolved Mn through pore waters is balanced against transport of solid phase diagenetic

The rapid flux of organic matter to the seafloor and its mixing into the sediments is reflected in the suboxic pore water chemistry at site H. Pore water chemistry may be best understood in terms of the sequence of diagenetic reactions in sediments (Table 1), which has been shown by MANOP and others to be universally followed [Freelich et al., 1979]. With increasing depth, pore water chemistry is characterized by a NO₃ increase (reflecting O2 reduction and oxidation of organic N), a NO₃⁻ decrease (reflecting NO₃ reduction), a Mn++ increase (reflecting MnO₂ reduction), an Fe++ increase (reflecting Fe₂O₃ reduction), and a SO₄ decrease and an NH3 increase (reflecting SO4 reduction). Two other reactions are also occurring: Mut* must be oxidized by O2 where it goes to zero, and Fe⁺⁺ must be oxidized by O₂, NO₃, or MnO2 where it goes to zero.

In site H pore waters (Figure 4), the NO, increase, and O₂ consumption, are complete by about 1 cm depth. NO₃ reduction begins at about this depth and continues throughout

Rates of organic carbon oxidation in these reactions, calculated from diffusion reaction models, are given in the following table, along with the rain rate determined by sediment traps and the burial rate determin product of the organic C concentration and the sedimentation rate, At site H,

Organic Carbon Balance at MANOP Site H

Primary production Flux to the seafloor Oxidized by O₂
Oxidized by NO₃ (11.6) (by difference) Oxidized by MnO₂ $0.06 \pm$ Buried below 40 cm

Units: µmol cm⁻² yr⁻¹.



Fig. 2. MANOP cartoon, showing project personnel and their roles.

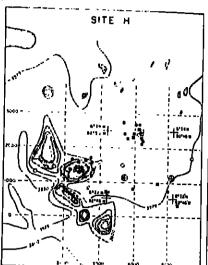


Fig. 3. Bathymetry and coring locations at MANOP site H. Nodule cover increases from $\sim\!\!4\%$ in the north to $\sim\!12\%$ in the south. The ross-hatched areas are free of nodules. Boxis and circles represent coring sites.

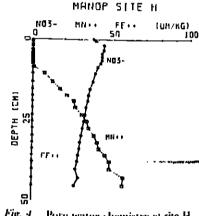


Fig. 4. Pore water chemistry at site H. The changes occurring with depth reflect the equential reactions outlined in Table 1.

about 2% of the organic carbon reaching the scalloor is buried to at least the depth of the core bottoms (*-40 cm). Similar amounts of organic carbon are oxidized by NO₃ and MnO2. NOv and MnO2 exidation rates vary by about a factor of 2 throughout the site. The results show that nearly all the organic matter reaching the scalloor is oxidized by O2. The other oxidants, while not important in regenerating organic C, nonetheless are crucial in mediating the amount of organic G (and nutrients) ultimately removed from the system by burial.

As might be expected, diagenetic Mn remobilization has a major influence on the distribution of sedimentary manganese (Figure 5). All cores have a surficial Mn rich zone 10–20 cm thick, with solid phase Mn concentrations reaching 6%. Such a Mn-rich zone forms when Mn++ released to pore waters by disgenesis diffuses into the sedimentary mix ayer, is oxidatively precipitated, and is redistributed by bioturbation. It is noteworthy the the maximum in the solid phase Mn concentration is sometimes well above the depth re pore water Mn ** goes to zero. The feature suggests that some of the solid phase Mn profiles are not steady state features, but relict from a time when the site was more reducing and Mn++ oxidation occurred closer

MANOP Site H Results: Nodule Compositions and Growth Rates

Huh and Ku have succeeded in radiome cally dating one site H nodule, measuring. growth rate of 50 mm/m.y. for the top and 60 mm/m.y. for the bottom. The age for a nodule with a diameter of 8 cm would thus

TABLE 1. Reduction Reactions in Order of Decreasing Free E

	Decreasing Free	Energy Yield
Reaction	:. •	Indicator
$O_2 + CH_2O \rightarrow CO_2 + H_2O$ $4NO_3^- + 5CH_2O + 4H^+ \rightarrow 2N_2 + 5CO_2 + 7H_2O$ $2MnO_2 + CH_2O + 4H^+ \rightarrow 2N_2 + 5CO_2 + 7H_2O$		NO ₃ - increases
$2MnO_1 + CH_2O + 4H^+ \rightarrow 2M_2 + 5CO_2 + 7H_2O$ $2Fe_2O_1 + CH_2O + 8H^+ \rightarrow 2Mn^+ + CO_2 + 8H_2O$		NO ₁ decreases
$2\text{Fe}_2\text{O}_1 + \text{CH}_2\text{O} + 8\text{H}^+ \rightarrow 2\text{Mn}^{++} + \text{CO}_2 + 8\text{H}_2\text{O}$ $8\text{O}_4^- + 2\text{CH}_2\text{O} \rightarrow 2\text{CO}_2 + 8\text{H}^+ \rightarrow 4\text{Fe}^{++} + \text{CO}_2 + 8\text{H}_2\text{O}$	1	Mn ⁺⁺ increases
SO_4 + 2CH ₂ O \rightarrow 2CO ₂ + 3 + 2H ₂ O + 5H ₂ O		Fe ⁺⁺ increases,

For each reaction, the 'indicator' is the chemical whose pore water concentration change is middle. easily monitored. In O2 reduction, NO3 is produced by oxidation of organic N (not shown in the simplified strochiometry):

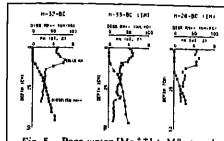


Fig. 5. Pore water [Mn++] (µM/kg) and solid phase [Mn] (weight %) in three cores from MANOP site H. These data record re duction of MnO2 at depth and upward diffe sive transport of dissolved manganese, followed by precipitation at 10-15 cm depth and mixing to the surface by bioturbation.

SITE H PHOLE NODULES

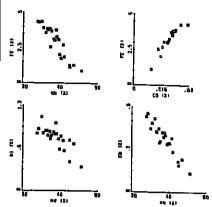


Fig. 6. Scatter plots of the composition of whole nodules at MANOP site H. High Mn nodules are enriched in sedimentary diagenetic manganese. This diagenetic manganes dilutes Cu and Ni.

be about 700,000 y. The growth rate is very rapid and undoubtedly reflects the supply of diagenetically remobilized Mn.

The Fe, Mn, Ni, Cu, and Co concentrations of whole manganese nodules at site H are summarized in scatter plots in Figure 6. The most striking feature of the composition is the high Mn/Fe ratio. It has long been recognized that high Mn/Fe ratios are characteristic

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Cover. A nearly vertical fracture in the granodiorite of Lake Edison, Sierra Nevada, California, left-laterally offsets a mafic inclusion and an aplite dike by 8 cm. Structural data demonstrate that this small strike-slip fault nucleated on a preexisting dilational fracture (joint). Thus this frac-ture records two distinct deformational events: an extension followed by a left-lateral shear. Strike-slip fault zones with offsets of up to 100 m developed from similar small faults. From, Nucleation and growth of strike-slip faults in granite, by P. Segall and D. D. Pollard, J. Geophys. Res. 88, 555-568.

of nodules underlying highly productive surface waters [Price and Calvert, 1970], and result from the remobilization of Mn++ in sediments by organic matter oxidation, as discussed earlier. How the nodule composition productivity relationship is mediated. nowever, remains a mystery. At MANOP site H, manganese is reduced in the MnO2 reduction zone, between 10 and 20 cm, and is oxidized and precipitated out at about 10 cm depth. Hence, Mn diffusion through the oxidized zone to the sediment-water interface is far slower than Mn incorporation into nodules (Table 2). This result shows clearly that nodules cannot grow from upward-diffusing diagenetic Mn⁺⁺ if our pore water profiles are steady state features. Nevertheless, since the Mn++ concentration rises by 5 orders of magnitude between bottom water and the MnO2 reduction zone, it is difficult to escape the conclusion that MnO2 reduction is somehow responsible for the high Mn/Fe ratios of nodules under upwelling areas. But how is Mn supplied to such nodules if not by steady

Several possible explanations may be in-

state upward diffusion?

voked: First, the MnO2 reduction zone may randomly migrate up and down in the sediment (perhaps in part due to the occasional creation of microenvironments) and, at certain times, lie shallow enough to supply Mn to the interface. Perhaps, for example, the MnO2 reduction zone migrates in response to long time period changes in the forcing functions, such as a change in the sedimentation rate associated with glacial periods. Another explanation is that the depth of Mn⁺⁺ oxida tion may be fixed at about 10 cm, and manganese nodules may be placed at this depth or short intervals by bioturbation, either as a result of being pushed down by animals or being covered temporarily by sediment mounds. Today, about 5% of the manganese nodules are at the Mn⁺⁺ oxidation depth. We do not know if these nodules are in a short active growth phase or are simply enroute to being buried. A third possibility is that the nodule Mn may derive from solid phase oxidized or reduced Mn (e.g., MnCO₃) brought into the Mn-rich zone by remobilization. This Mn would be transported from the depth of Mn** oxidation (about 10 cm) to the sediment water interface by bioturbation. This hypothesis gains plausibility from the recent paper by Pederseic and Price [1982] showing a high level of reduced Mn in solid

Whatever the exact mechanism by which nodules incorporate remobilized Mn, its occurrence has a simple and dramatic effect on nodule composition (Figure 6). Dymond has shown that compositions of whole site H nodules reflect mixing of two end member , a nodule bottom end member incorporating Mn remobilized by MnO2 reduction and a nodule top end member precipitating from seawater and thought to derive from oxidative diagenesis. The anticorrelation between Mn and Fe in these figures is dictated by simple mass balance but the linear mixing lines for Ni versus Mn, Cu versus Mn, and Co versus Fe can be explained only as end member mixing. The positive covariation of Co with Fe is expected, since Co is present in an ironrich phase; however the anticorrelation between Mn and Ni and Mn and Cu is the opposite of that observed in most pelagic not ules. Cu and Ni in site H nodules are likely found in a Mn-rich mineral; the very low concentrations of these metals in nodule bot toms probably reflects a swamping of pore water Cu and Ni by diagenetic Mn and exclusion from nodules because of their low concentrations relative to Mn in pore waters.

Summarizing our site H results, our detailed studies show that the seafloor at site H has the characteristics which one might expect for a relatively shallow abyssal site underlying high productivity surface waters. A high rain rate of organic matter sustains a vigorous benthic macrofaunal community and rapid organic matter degradation with the sediments. Nearly all organic matter falling to the seafloor is degraded by O2 oxidation; oxidation by MnO2 and NO3 contributes negligibly to regeneration but is imporburied and ultimately removed from the system. Sediments are influenced in a number of ways by organic matter degradation, most noticeably by manganese recycling. MnO2 reduction also supplies manganese to the nodules and leads to very high growth rates, although we are unable to single out the diagenetic Mn transport mechanism. The extensive incorporation of diagenetic manganese into nodules is reflected by the rapid growth rate and high Mn/Fe ratio of site H nodules and the difference between top and bottom chem-

TABLE 2. Crowth Rates of Nodules at the MANOP Sites and a Comparison of Manganese Accumulation Rates in Nodules With the Flux of Diagenetic Manganese Through Pore Waters to the Sediment-Water Interface

Growth rate (mm/		Mn accumu- lation rate, moles cm ⁻²	Diffusive Diagenetic Flux, moles cm ⁻² yr ⁻¹	
R S H	0.6-3 5 50	3 × 10 ⁻⁹ 70 × 10 ⁻⁹	0.01 × 10 ⁻⁹ ≤2 × 10 ⁻⁹	

istry. The top-bottom contrast dominates nodule composition at site H: nodule composition can mostly be explained in terms of mixing two well-defined end members of constant composition.

Comparison of Results at Other

MANOP has retrieved seasonal sediment traps from M and H and annual traps from M. H. and S. Annual near-bottom total particulate fluxes at M and H are similar; at S the value is about a factor of 5 lower (Table

TABLE 3. Summary of Organic C Fluxes at MANOP sites M, H, C, and S

	Site			
	М	Н	С	s
Flux to seafloor Oxidized by	12	15		1.8
O ₂	(10.2)	(10.6)	19	1.6
NO ₃ -	1.1	0.08	0.08	
MnO ₂	0.15	0.06	0.01	
Fe ₂ O ₃	0.014	2.00	0.0	
SO ₄	0.15		2.3	
Buried below			-1.5	
40 cm	0.4	0.2	0.2	0.01

Among these four sites, pore water chemistry changes such that pore water profiles are progressively stretched out as organic matter ain rates fall (Figure 7). That is to say, as the flux of organic matter reaching the seafloor decreases, zones in which the various oxidants are consumed occur deeper within the sediments. Only when comparing sites M and H does this generalization fail. Fluxes to the seafloor are similar at these two sites, but the redox zones are much closer to the sediment surface at M. The sites differ in that M has a higher sedimentation rate, while nodules are present at H. More intense diagenesis at M. may reflect more burial of organic matter due to the faster sedimentation rate (e.g., Muller and Suco, 1979]. Alternatively, it might be that more organic matter is oxidized before burial at H because nodules allow a more vigorous benthic community to exist: if so nodules must have a major and heretofore unsuspected impact on sediment geochemistry.

The solid phase Mn distributions at M. H. C, and S are similar to what is expected from the pore water Mn** gradients discussed earlier. At M and H, the depths of pore water Mn** oxidation are within the sedimentary mixed zones, and there accordingly are MnO2-rich bands near the sediment-water interface. The depth of MnO2 reduction is closer to the interface at M, and the Mn-rich layer is thinner. At C. Mn++ oxidation occurs at about 20 cm depth, probably just below the mixed layer. The solid Mn distribution is thus characterized by a discrete Mn-rich layer centered at the depth of Mn ++ oxidation. At S, where there is no pore water evidence for MnO2 reduction, and at R, where pore waters are also assumed to be oxidizing, there is nevertheless a sediment surface zone in which Mn is slightly enriched. The origin of this feature is unknown.

Key features of nodule composition at sites

H, S, and R are summarized in Figure 8, and growth rate data is given in Table 2. The most striking result is the high growth rate and Mn/Fe ratio at site H compared with the other two sites; these features reflect the supply of diagenetic Mn from the underlying ment. It is more difficult to understand why, if there is no MnO2 reduction at site S, the Mn/Fe ratio of site S nodules is higher than that at R. Dymond has argued that metals in site R nodules are primarily hydrogenous; that is, they are derived from precipitation out of seawater. Site S nodules are thought to have a diagenetic Mn componenthat derives not from MnO2 reduction but from Mn released from sedimentary ferromanganese hydroxyoxides when Fe reacts with biogenic SiO2 to form nontronite [Lyle et al., 1977]. Since both R and S nodule bottoms are richer in manganese than tops, the hy-drogenous and oxidative diagenetic components are thought to supply metals at both sites, with the oxidative diagenetic component being greater at S.

At site S, the upward manganese flux at the interface, calculated from the pore water concentration gradient, is 3 orders of magnitude less than the rate at which manganese is assimilated into growing nodules. Therefore, another source of manganese is required, and this is believed to be solid Mn released very close to noclule surfaces as a result of the oxidative diagenesis reactions discussed earlier. Thus, while we confirm the increase in

nodule Mn/Fe ratios with increasing productivity, our work supports the mechanisms proposed by Lyle et al. [1977] and indicates that this relationship is mediated in ways very different from that envisioned by earlier workers. In oligotrophic waters and upwelling boundary waters (as at site S), productivity increases nodule Mn/Fe not by providing diagenatic dissolved Mn++ but by providing SiO2, which sequesters Fe and releases Mn to nodules in an oxidative process. In higher productivity waters, where the Mn++ oxidation zone is close to the interface, incorporation of dissolved diagenetic Mn++ is possi-

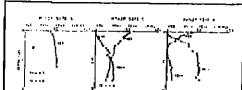
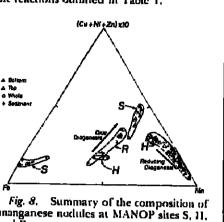


Fig. 7. Summary of pore water concentrate tions of the redox indicators at MANOP sites S. C. and M. Again, chemical changes reflect



ble only if nonsteady state conditions are invoked. If we assume steady state and growth of nodule bottoms at the interface, the very high Mn/Fe ratios of nodule bottoms at site H must be due to incorporation of solid diagenetic Mn mixed up by bioturbation from the Mn⁺⁺ oxidation zone.

It has been widely demonstrated that, among pelagic nodules, Cu, Ni, and Zn concentrations increase with increasing manganese. At sites S and R this relationship is followed, both when comparing whole modules from one site to another and when comparing tops and bottoms at the same site. At H the trend is reversed, for reasons discussed

In summary, sediment fluxes to the seafloor decrease in the same order as surface productivities (M = H > C > S). As productivity drops, redox zones in the pore waters are spread out to greater and greater depths. At the two high productivity sites, Mn is remobilized and oxidized within the sedimentaty mixed zone, forming a Mn-rich layer near and at the interface; at site C. Mn is remobilized and oxidized just below the mixed zone. forming a discrete Mn maximum, and at site S the MnO2 reduction zone is not penetrated y our cores.

Nodule growth rates and Mn/Fe ratios increase with increasing organic matter flux to the seafloor. (Ni + Cu + Zn) increases with increasing Mn until productivity becomes very high, at which point the trace metals are drowned out by Mn and their concentrations in nodules drop.

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News & Announcements

Glomar Challenger Finds **Ophiolite**

Deep Sea Drilling Project (DSDP) hole 504B located in the eastern equatorial Pacific, 201 km south of the Gosta Rica Rift (CRR), is unique in several ways. Hole 504B extends 1.35 km below the seafloor, which is at a depth of 3.46 km; it has penetrated selsmic layers 2A; 2B, and part of 2C and for the first time has provided a very complete section; and it has bottomed in what has been interpreted as a true ophiblite complex. These results constitute for the first time long awaited confirmation of accepted models upon which most oceanic grust theory has. been based.

A recent report of DSDP Hole 504B noted that '... one is led to question the validity of using ophiolite as models of ocean crust' (Nature. December 16, 1982). That statement was representative of the state of uncertainty that existed before the hole was drilled. The drill site is located on magnetic anomaly 5', which has an age estimate of 6.2 m.y. The location, south of the CRR, lies on the easternmost arm of the Galapagos Spreading Center, ideally situated over ophiolic lithostratigraphy, if most current models of the oceanic crust are correct. Hesitation with the acceptance of these models has arisen in recent years from the rarity of dredged and drilled rocks that can be positively identified as being samples of an ophiolite complex. Hole 504B, being along the southern flank of the CRR, should be a good test case.

What was expected to be encountered in the hole was a penetration of seismic layer 1 (pelagic sediments), then fresh to altered basalt pillows and flows (seismic layer 2A). metamorphosed basalt pillows (seismic layer 2B), and finally seismic layer 2C, the characteristic metamorphosed basaltic dike complex. The cutire seismic layer 2 is variable, but averages about 2.5 km in thickness. The underlying layer 3 is thought to consist of gabbros and more or less serpentinized ultranialic cumulate rocks of approximately 4.5 km thick-

Drilling of hole 504B on DSDP leg 83 was a continuation or re-entry of the hole that was started on legs 69 and 70. Leg 69 extended to a depth of 489 m, leg 70 to 836 m. With a few complexities, the lithostratigraphy turned out to be just about ideal. Basement rocks were encountered at about 275 m. For the next 575 m depth, pillow lavas, flows, and

tectonic breccias were encountered. This pillow/flow sequence was underlain by a 209 m transition zone consisting of pillows and minor flows cut by dykes. At depths below 1055 m (BSF), no more pillows were found; only a sheeted dyke complex characteristic of ophio litic models of the oceanic crust was drilled to the bottom of the hole.

An extensive suite of geophysical measure-ments were made in addition to the collection of drill cutting samples. Down hole logs of sonic velocity and attenuation, X ray density. neutron porosity, and resistivity were obtained. A boreliole televiewer was used to record fracturing and reflectivity. Thus, the study provided an excellent opportunity to compare geophysical depth data with petrographic analysis of the well samples.

Layer I contrasts in properties with those of the basement rocks in that the first 275 m of sediment at hole 504B are mostly siliceous naunafossil oozes, grading into chert at the

Seismic layers 2A and 2B correspond rath-

er well with the geophysical logs to the open-ly fractured and smectite-filled fractured pillow-breccia-flow layers, respectively. The interval between 846 m and 1.055 m, design nated petrographically as the layer 2B-2C transition zone between pillow/flow and dyke complex, was not so subtle in the representation of the geophysical logs. There was a relatively sharp transition, extending no more than about 50 m, as represented in the geophysical logs. A distinct layering, for example, was deduced from bulk porosities calculated from resistivities. The layering corresponds to the seismic layers 2Å, 2B, and 2C, which is the first observation of a section through layer 2. The results of the DSDP

Hole 504B study confirm '... that the main features of the upper part of an idealized ophiolite sequence occurs in the oceanic crust (Nature, December 16, 1982).-PMB

Expedition Invites Research Opportunities

A Long Lines Expedition for Hydrographic stations will be made along the Greenwich meridian from 7°N to 35°S, with a port stop at Capetown, South Africa, then southward to Antarctica and westward through the Scotia Sea, ending at Punta Arenas, Chile. The work will begin in the fall of 1983 and finish early in 1984. Surface to bottom measurements of temperature, salinity, oxygen, and nutrients will be made at approximately 110 km intervals. The purpose of the expedition is to collect data to study the general circula-tion of the eastern South Atlantic Ocean, the Antarctic Circumpolar Current, the eastern extension of the Weddell Gyre, the flow of deep water from the Weddell Sea that extends northward east of the South Sandwich Ridge, and the regional oceanography of the

The expedition offers an opportunity for measurements of such other characteristics (tritium, heljum-8, freon, carbon dioxide, etc.) as can be accommodated aboard. Parties interested in carrying out such programs should call or write J. L. Reid at the Scripp Institution of Oceanography, La Jolla, Calif. (telephone: 619-452-2055) or W. D. Nowlin at Texas A&M University. College Station (telephone: 713-845-2947).

U.S. Ocean Policy **Under Law of Sea**

How the United States' use of the ocean will be affected when the international law of the Sea treaty comes into place will be explored at the University of Rhode Island's (URI) Center for Ocean Management Studies' (COMS) seventh annual conference, June 12-25, 1983. Significant impacts on U.S. ocean interests and policy of the United States' decision not to sign the worldwide convention will be examined in detail.

Among the topics to be discussed are the international political context of the negotiations and the U.S. position as it changed from support to opposition; the costs and benefits of signing and not signing the treats; the status of nonseabed provisions as customary international law; special problems and opportunities of scabed mining and navigation; and suggestions for future U.S. strategies. The Law of the Sea Treaty (Ens. June t. 1982, p. 523) was formally signed recently by almost 120 nations; two dozen countries, inchiding the United States, have refused to sign, however.

Lawrence Juda, chairman of the URI Department of Geography and Marine Affairs, will chair the conference. John A. Knauss, vice president for marine programs at URL is a member of the planning committee. He has served as an advisor to the Law of the Sea delegation. The conference will be held at the URI Narragansen Bay camous.

For additional information, contact the Center for Ocean Management Studies. Kingston, RI 02881 (telephone: 401-792-

Meetings (cont. from p. 41)

T51A-07, J. J. Jueger; T51B-08, A. Schedl; T52B-12, T. Matsui et al.; T61B-03, E. Bonani and K. Crane; T628-01, P. L. Ward; T62B-05, K. Cranc: T62B-08, L. Gamboa: T71B-09, C. H. Scholz; T71B-13, N. Warren; T81A-05, K. D. Gerdes and P. Styles: T81B-07. M. Wyss; T81C-02, D. A. Falvey; T82A-13. L. Smith: T82C-10, J. F. Swenney.

V42A-03, H. Z. Lu and M. L. Grawford: V71C-06, G. A. McKay; V81C-08, L. G. Medaris et al.; V81C-12, A. K. Baksi; V81C-14, P. J. Leier; V81C-24, W. H. Zoller et al.; V81C-25, D. L. Finnegan et al.; V81C-26, D. S. Ballentine et al.; V81C-27, J. M. Phelan and W. H. Zoller; V82B-04, G. T. Nixon.

Late and Revised Abstracts

Atmospheric Sciences

Breakdown in Contres Air

J.M. TRLER, B.C. PASSIMEIM, W. WILLEY, Y.A.J. YAN LINI (Hissian Research Carpo

Offerercas between braskdown in ionized air and breakdown in non-ionized air haws been observed. Recently a
model was formulated to explain the creation and propagation of electrical discharges in ionized air. The
stresser growth rite was determined by the rate at which
current flowing in ionized conductive air can value air
temperature at the tip of the stresser to full lawral
ionization (kTwl ey). To test this zodal, an experience
tas parformed at the Defense Ructees Agency's AudoMa
flash 1-ray Facility at Herry Diamont Laboratory (sioned
energy =5 MJ, max ghoton energy will Rey). In this experiment radiation (with rad ey Did rad/s) provided the ioniration and a separate 100 My pulser provided the field
(\$1000 Myrch). At least five times tirement was were created
which propagated 0.75 cm during AudoMa's 150 no radiation
takes width, and quenched on cessation of radiation.
These ministure atmeners were photographed, their growth
valcity electrophically measured and the current voltage
than test air and the contraction of providing policity
alectrophically measured and the current voltage
than test air and the provide the contraction of policitions is your enough to lend considerable credibility to the theory.

An Apparent Scale Difference between Doppler Stations and SEASAT Altimatry Geoids

300 G. KIRK (Goodynamics Corp., 55 Hitchcock Way, Saite 209, Santa Barbara, CA 91105)

Good height values from NR112 coordinates at 310 control north values from the life coordinates at 310 costs a Doppler stations having good ties to make see level here conjured with the nearest 15' x 15' grid point values in the NAVOCEANO SERAM eleterary good height date set. A rean difference of 2.2 meters was obtained. A similar comparison of Doppler values with OSU SEARA 1' x 1' mean good height values results in a mean difference of 2.2 costs also. These mean differences were obtained after recoval of 2-coordinate differences identified in various and the control of the coordinate differences identified in various neglects and differences identified in various analyses and verified by the 2.3 meter origin offset between the ellipsoids which best fit the RAMILARQ and OSU goolds. These differences suggest that scale or other systematic errors in excess of 1 rater remain is goold detarminations. Passible Caplamations (notude:

- 1. Systematic mear-shore tide rodel, current, or
- Seastate errors, 2. Errors in alticoter calibration, or its
- interpretation.

 3. STASAT orbit radial errors.

 4. NRLIIZ scale error.

future light Persisten Gravicy and Appello

B.E. Chiril. (Geosphisics Branch, Mass.

For the last 2 years MACA has been developing the concept of a geopotential research mission that that would be taken the earth's gravity and segments [leids with a resolution of 100 he gay the entire globs. Proposed for Jameh Loward the and of this dearts the similar would consist of the spacecraft in finglinal polar orbits at shout 160 he satisfue and separated by a few bandward kilmesters. The relative action action of the two spacecraft oill be used to derive the sactive gravity sequential and one of the spacecraft will carry bealess and vector bigs no locaters. With a lifetime of guestic the state of the spacecraft will carry bealess and extension of a separated to an eccurrency of short i space at the service in the spacecraft will core broades at the service in the spacecraft will over it may at the service in the special over block sizes at 160 he at 160 h

Hydrology

The Boyslops-Ray Isohnique and Chance Compleyint Prograssing TEGODORE G. BORYS (Sureau of Beolemention, 2800 Cottage Way, Sagramento, CA 95825)

An unpublished mass-curve type of anelypie la cashined with chance constraint programming accompts. Thoughts landing to this combination were attended by Eleman 1979 article. [/

The same-curve technique in quantion was developed by Fobert A. Villique. It has not onen published. It is a technique which is easier to apply than the techniques in the cited erticle. Cochiming it with chance commetrate descepts permits the development of a chance commetrate from the development of a chance constraint formulation which does not have some of the problems identified by Klasse. It should be recognized, however, that all such "sale-durys" techniques rely on a treacherous fiction. The fiction is that a perfect foresight operation policy is possible.

1/ Kienen "Storage Hass-Curve Analysis in a Systems /LLo Perspective." <u>Water Resources Research</u>. 1979, v 15, p 2.

Aufwuchs is a sensitive, low cost tool that can aid regulators and dischargers in determining effects of municipal and industrial wastewaters on the blots of local receiving water. Effects of blost inulatory [municipal] and toxic (simulated industrial) discharges on aufwuchs grown on artificial substrates wern assessed in 3000 L analog tanks. Parameters considered include 02 generation, 02 uptake, chlorophyll a and bloadss. The method shows clear differences between various diffution levels simulating those accountered. bioess. The method shows clear differences between various dilution levels simulating those encountered in San Francisco Bay. The results from tank experiments have corroborated results of simultaneous field studies which also showed blostimulatory effects

American Society of Limnology and

Jolla, CA 92030) R. Recht (UCSB, Santa Barbara, CA 93106)

water stronty influenced by coastal upwalling of less than 2 weeks duration, a railot pluss 1-2 months old, and coasto water with no algorithms old, and coasto water with no algorithms of apsaining effort in the area by the northern enchory. Engraulis morder (Ulrard), is Unfarred Liron the observed distribution of that were and laws. When recent managing

A CONTRACTOR OF THE WAR WAR AND THE WAR

Circulation in Sulsun Bay: Data and Numerical

veriations in see level in Eulaun Ray are atrongle

Analog Tank Systems in the Development of Biosssey Rethod Using Aufwuchs

D. V. SMITM (Sanitary Engineering and Environmental Health Research Laboratory, Richmond, CA 94804) J. C. ROIH (Sanitary Engineering and Environmental Health Research Laboratory, Richmond, CA 94804) A. J. HORNE (Sanitary Engineering and Environmental Health Research Laboratory, Richmond, CA 94804)

Post-Upwelling Plankton Communities of the Anchory Spanning Environment R. M. Owen and A. Alvarino (MCAA/MAPS), La Jolla, CA 92000

he report on measurale spatial variation of phytoplankton and small apoplankton corestration and occupation, and infer their begins a variation in and beyond the anchowy abolizat off Southern California. A variety of stipboard and setallite observations in April 1981 clearly define the environment from which sample sets were dreen for enumerations of small planktons we sampled a 200 km plume of salter stronly influenced by coastal upwelling of less than 2 weeks duration, a relief relief

interest from the openion of intribution of their eggs and larvae. Very redent spathing effort was restricted to the region inwhore and south of the new plane and was highest than the plane limits. Reliet place and of tabore oceanic water were devoid of spathing products.

mear the plume limits. Relice plume and offiners occasin water were devoid of spanning products.

Compare with ambient occasile sater, care where of the new plume was coler by about 3 deg. C, more salins by 0.1 o/oc, and richer in chierephyll by factors of 10-90. Nitrate, intrite, phosphate and allicont concentrations were elevated in the mixed layer of the new plume. The continuing local antichment of the photochine, was severally greater in the new plume. Thus continuing local antichment of the photic layer is likely be have contributed to local antichment of the photic layer is likely be have contributed to local antichment use the exch distinished stability in the plume. Also likely to have contributed to local antichment use the exch distinished stability in the plume wertical sections of deasity show decrease of vertical gradients in the upper local and which plume limits. The destrability and we surded that the local Richerdson number approached the critical value for intensified vertical sixing. Effects of line source upwalling thus appear self-perpetrating wall downstream of the primary upsalling, to the local tricked with the source upwalling thus appear self-perpetration and the intensified vertical sixing. Effects of line source upwalling thus appear self-perpetration and intense actions, and the formstream of the primary upsalling, to the formstream effects, in response, settled volumes of plankton wave greater by feature of the primary upsalling. The phytoplankton consentity of the plume was designated by chair distons; as high chestoceros spe, and the sobplankton by Calena pacifical.

MOY A. WALTERS (USCS. Hento Park, CA 94025)

See level date and our ont mater date gathered in northern See Francisco May are analyzed with respect to tidal variations (parloss of one stay or less) and low frequency wariations (periods of several days and longer). As this area is of several days and longer), he this area is of several days and longer), he this area is of several days and longer). Be this area is of several days and longer in observed and longing sense, this enalysis attempts to identify the physical processes that we important to circulation and miling. The tidal variation desirates the coupled to constal ass level variations that are caused by moteorological effonts, and the times cause o see lovel stup that is larger during apring tides than during neap tides. The low frequency currents display a density grivan gravitational circulation and a tidelly driven horizontal mean flow, both of which very strongly with the spring-neap tidel cycle, in addition, the solt flux as computed from each data set doponis really on the sean velocity lines the sean satisfit (time-mean advoctive component) and not the correlation between tidel variations in velocity and satisfity dispersive component.

In superiorist models are used to increase.

and selinity (dispersive component). Two momentary poles are used to increase understanding of the dynamics of Soloum Day: It a finite element idda gough Lased upon the Shallow mater equalions which computes the amplitudes and phases of the various idal species and emprovince the essential features of the idea, and it residual circulation model (Fulerian) which is currently two diseasains; increased (fortunitions or expression the addition of vertical variations to expression the dynamics inferred from data analysis.

Matring of Sulf Stream Rings with Altimutry

(both at Jot Propulsion Laboratory, California Institute of Tachnology, 4800 Oak Grove Drive, Passdens, C4 91109)

The dynamics of Galf Strone Rings during August, 1976 are examined using combined SEASA7 and GEGS-3 sitisetry in the northwest Atlentic. Attlectric heights are used to map the geostrophic nessurface height residuals with respect to a regional goold. Results compare feverably with

Geostrophic surface current fields are produced from the height residuals. Using a long-term sean surface for the region, generated by using several years of GEOS-] alliestry, we attempt to measure transient eddy/assa flow nonentum exchanges. Accuracies associated with these altimetric aspens methods are potentially comparable to those attainable from bydrographic surveys. Suggestions are made for using GEOSAT (attention stabiling are made for using GEOSAT (attention stabiling to be launched in 1984) to study ring dynamics.

Constal Current Energatics

University of Alaska, Pairbanka, AK 99701)

University of Aleska, Pairbanks, AK 99701)

The Alaska Coastal Current is an energetic, parrow band of brackish water which flows weatward along the northern Oulf of Alaska. Its source inputs are the high rate of frashwater funoff from the coast and the longabore ensurity wind. The frashwater influx causes a cross-shalf density gradient which drives a longabure baroclinic current. The shortward Ekman transport, which results from the longabore wind, tonds to accrete the brackish water into a marrow band and thus maintains the integrity of the fine. The frashwater input is treated as a fluid tapacita, which is analogous to an electrical capacitar, which is analogous to an electrical capacitor to which the energy is stored due to a voltage gradient. Expressions are derived for the energy distribution in the coastal current as a function of freshwater influx and wind stress. Energy estimates are said for standy-state and transient scenarios and then compared to observed values that were satimated from a set of hydrographic statione.

The calculations indicate an appreciable variation in longabore energy as a function of time.

032A-10A Hatteing of Gulf Street Biogs with Attlactor

d. L. HITCHELL.
O. H. BORN
(both at let Propulsion Laboratory, Galifornia lealitate of Technology, 4600 Oak Grove Drive, Passdana, Cd 91109)

The dynamics of Oulf Strong Rings during August, 1979 me granized dwing combined Shiart and GROS-3 attacts. Although the Dorthwest Atlants. Although beights are upon to map, the gederophic seasurfees Deight residents with respect to a regional gests; Smalts comper favorably with company the decrease of the profit of the state of the present that the profit of the profit of the state of the present the season of the state of the st Genetrophic surpose current fields are produced lyou the height residuals. Using a long-term mean surface for the region, generated by union separal years of 650-3 attactory; we attempt to measure transfer, addy-mean flow schements with the surpose and the produced and the produced with these altimetries.

seping pethods are potentially comparable to those attainable from hydrographic surveys. Suggestions are made for value 0.05.17 (sitizatris entallite to be luwiched in 1984) to gudy ring

ESTA A THEORY OF PARTY AT THE ACTS OF THE EAST PARTY REPORTED TANK TO THE PARTY AT THE ACTS OF THE EAST CASE OF THE CASE OF THE ACTS OF THE CASE OF TH

A sold servible study of a fast spreading (42 cr/yr) Hid-Ocean-Bidge appear ted to the discovery of intense lightwhen of a thirty that the fire bige man 12 50/25. Leanty four office with a tive tent, and sixty inactive high official deposits over found within a narrow graden averaging about \$10 to in which along a 25 by long segment within a contraction. sacraging about with a in which along a 20 m long sug-ment of the thige circ 1 be globen as flored with light boods to deet those including collapsed pits or low labe star tures. Tree both deep types Comera was that, and coined salon pathle observations, it is esti-mated that the average sprange of the hydrothormal de-posits (1910) in in discourse) along the rise and lies between 190 to 100 metrics.

the hydrothermal deposits found in the central grader are is thereof to have turned rapidly for the order of a few decade of text at left investigations of the grader of a few decade of text at left investigations of the chief the chief to to define the proceded of a settle of the ray which there exist its height by at an in 5 days. The concentration of the major retails phases (Page), and the discount in the relating lot studies (20°C) is about 0.00-C), populater, from an average flow rate of to 12°C. If the collected that the ross of netails, period, the charged from an active chiercy is in the order of 80-112 Mg, per day.

The rest establic hydrothereal deposits were disco-tered on an off-sails precional located 6 in East of the tideo date. The hydrothereal deposits found on both the ridge as: and on the measurement are similar in competi-

Seismology

SGDR-03 RBVDSPD

Microschapfolty Near Manageth Laken Continuone A.T. SMITH Grawrence Livermore National Laboratory, P.G. Gax Riss, Livermore, CA 94550)

Interactory, P.G. San Rin, Livercurre, CA 945501

During August 1982, a schade antwork of 14 stations was accupied near Marmonth Lakes, California, at the within the Long Valloy Caldern Instruments Included vertical and 3-component volonity transferers, and a forced-balanced accelerometer. All stations recorded at 180 samples/second on Surenguether 198-1985 with an array rigger criteria to reject from noise and to insure accurate relative liming.

The network recorded USGS refraction shots running north along US 395 from Casa Habita and cost near Moso lake. To determine the local velocity structure, a acriss of small since near onch scients station provided known sources. Hundreds of local earthquakes were also recorded to a tional imagnitude 5.

Prollminary locations for the microsaismidity suggest two trends extendity north from Laural Canyon. Is addition, a swarm of events was recorded on August 9. A simultaneous lowerslon determined hypoconters, station corrections, and velocity structure (Roccher, 1981). The swarm tocates along a vertical plane contered at the events occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a three-hour period along s 6.5 the sevents occur during a during the sevents occur during the during the sevents occur du

The events occur during a three-hour period slows s 0.3 km segment of the plane and between depths of 2.5 and 3.5 km. The maximum USGS code magnitude for these events is 1.5. Additional events occur to depths of 9 km, but not directly below this swarm The desper epleanters locate from 0.5 to 1.0 km from the swarm spleenters. The configuration suggests injection along a actual resultance are highest into desper events occur along the streams and the perimeter of the upwelling. Food mechanism and attenuation studies are proposed to constrain the origin of the avents.

*Work performed under the auspices of the 0.8.
Department of Energy by the Lawrence Livergord, National Laboratory under contract w-7405-ENG-48.*

Amplitude Coupling and Francesov Shifts for Pustings

GUY MASTERS (Institute of Geophysics and Planetary W slos, Scripps Institution of Oceanography Bully sity of California, San Diego, La Jolia Ca 9909) JEFF PARK (also at IGFP) PREEMAN GILBERY (qlao at IGFP)

It has been known for some years that the opinite force causes quasi-degenerate soupling of as and all force causes quasi-degenerate frequencies are dione what has not been previously realized is this this opinity pling gives strengtly observable effects to be applying gives strengtly observable effects to be applying gives at angle of the coupling in that sodes which are usually regarded as appeciate loads have a toroidal complete to request of this coupling in that sodes which are usually and vice verel, for example, the modes gives a significantly nousled to the modes of the sole of the coupling and vice verel, for example, the modes of the sole of the so

SPR-Magnetospheric Physics

Jean Places Discharges to a Medium-sized Vecuum Chamber

S.U. BOSMELL (Flasma Physics Laboratory, Australian Hationel University, Cauberra, Australia) F.S. KELIGGG (School of Physics and Astronouy, University of Ninnssota, Ninnssota, Ninnssota

Observations of beam-plasma interactions have been carried out in MTMEAT, a vacuum chumber at Australian feational University. WOMEAT is 3.5 maters long and ,0 mater clear dismater, and has a magnate field of up to 200 gausa. An elegation beam of nearly up to A00 at and currents to several ah was used usually with an interaction longth of a mater. As the current from the gun is increased from a few micro A to several ah, these sementially discontinuous transitions at observed in plasma density, luminosity, plasma volume, and/or R.F. emissions. The first transition (lowest current) seems to correspond to that found by Bernstein et al. It units only at pressures below about 2 10° Torr.

The R.F. emissions are very spike and seem to he shat in expected for solitons. Plasma electron acceleration and heating is time-correlated with these acceleration and heating is time-correlated with these

Bernstein, W., Leinboch, R., Honson, S.J., Mallinson, T., Garriott, O.K., Konradl, A., NcCoy, J., Baiy, P., Saker, R., Anderson, H.A., Kellang, P.J., Electron Seas (species Experiments, Geophys. Res. Letters, §, 127-130 (1978).

5MS L - 12A The Geometry of the Hasnetosphers. [[11] Topological Aspents of an Extended-Tail Charpin-Ferrary Range Consulty

It was suggested by Westworth (1957) that the clessical Chapman-Farraro problem may have an 'extended-tail' solution, in addition to the known Johnson (1950) 'tear-drop' geometry. An extended-tail C-F magnetocavity constitutes a 'ground-state, arco-order' solution, with addition of an INF Journal 1960: 'car-quop' genetry. An extendequate: C-f magnatocavity constitutes a 'ground-state, gara-order' solution, with addition of an INF representing a 'first-order' perturbation. Her experimental and theoretical developments have omst additional light on this problem, and it is the purpof this paper to develop qualitative aspects or the topology of this ground-state, extended-tail C-F

First, a qualitative existence proof for the extended-tail topology is developed. Them, a recently-observed high-latitude 'reversed-draping' of sub-solar boundary-layer field lines may be natural aspects of the C-F extended-tail topology. Finally, dymamic processes which are aspected to take place in the sarp-IMF, extended-tail magnetomphere are briefly lines.

SPR-Solar and Interplanetary Physics

Among various solar wind plasms and interplanetary abject: liet (1") juin octats the interplanetary has been reported to have a strong effect on the frequency of Po 3-4 magnetic pulsations observed on frequency of Po 3-4 magnetic pulsations observed on the ground (Protestays et al., 1971). These observations indicate that pulsation frequency is proportional to INF intensity. In this report we investigate whether a similar TMF effect exists for the Po 3-4 magnetic pulsations in space observed by the synchronous satellite ATS 6. In order to avoid the amplitude variation daused by changes in frequency or admit structure of stending Alfven waves, we select pulsation weeks with identical fundamental frequency of 1 miss at a fixed local time of 1100. The ratio of wave power in the higher frequency band including the 3th and 6th harmonics to the lower frequency hand including the 2nd and 3rd harmonics indicates a positive correlation with IMF intensity, but neither solar wind velocity nor IMF direction general advantage of 1 miss at a selection with IMF intensity, but neither solar wind velocity nor IMF harmonics indicates a positive correlation with IMP intensity, but neither solar wind velocity nor IMP direction causes a significant change in the power ratio. Our observation is in accordance with those made by the Russian researchers. However, the frequency of the how-shock-small bridge with the frequency of the how-shock-sesociated upstream wave attimated using a model for proton reflection at the how shook (Sonnerup, 1989) and ion cyclotron resonance in the upstream solar wind (Welbambe and Texasawa, 1982) seems to have little correlation with the power ratio. This result argues against the hypothesis that the upstream wave is directly related to the trequency of magnetospherio Po 3-4 pulsations.

Tectonophysics

T62A-OS REVISED

Carlos L. V. Aiken (Univ. of Texes at Dellas, P. O. Box 688, Richardson, TX 75080 G. Randy Keller (Univ. of Texas at El Paso, El Paso, TX 79968) Robert Coultrip (UTEP), Chender Ahujs (UTD), Ming-Ron Hong (UTD), David Voegeli (UTD) Richard Ely (Mondward-Clyde Consultants, San Francisco, CA 94(11)

GRAVITY BIUDIES OF THE PARADOX BASIN

The feasibility of using the Peradox Basin for radioactive waste disposal prompted the acquisition, merging and adding of data from 60,000 gravity stations and now terrain corrections from 30,000 stations for the certain corrections from 30,000 stations for the states of Colorado and Utah, and adjacent areas. Bougust and coatiqual haps were produced. Regional topography, and the shortest wavelength correlation indicating isoscatic componential melves the correlation indicating isoscatic componential melves the correlation indicating isoscatic componential melves the correlation and topograph at that wavelength is them used as a variable reduction of an ordered the correlating anomally which is them considered removed. The expected correlation of a broad fravity low over Colorado with the broad regional topographic high is seen. The correlation is not sectione at even the longest wavelengths in morthwest Utah. The rasultant residual anomalize display closely the known features such as the broad basine and whife.

If the sedimentary rook effects are resound, a large continuous high (+50) is seen over most of Utah and Colorado. The Paradox Basin list toward the south flank of the cast-west boundary of the high which decreases he dest-west boundary of the high which decrose ptly along the Arisons-New Mexico border. The Paradox Sasin region itself is not anomalous. The nest significant large scale anomalies superimposed on this high are a north-south low slong the Wassich front considered by some to be due to the complex juxaposition of several deep (satures, and a north-sat-aouthwest low along the Colorado Mineral balt. Excellent correlations the Colorado Mineral balt. Excellent correlations

Three Tears of French Sea-Seam Activities C. Eddy (Contre Ocean De Bretagne, Brest Cedex

Tranco)
The CHECO (Tranch Mational Center for Queen's Exploitation) has equiped the Samenroh Wanest Jean Charact with a multi-base somer SEA-BEAM in 1977. He has entrusted the BMDO (Bureau Mational das Donness Ocaniques) to devision a software for processing and crobiving adm-base data; that memory

- Post-processing of data, ashure on hig computer, for contouring plong the ships a track,

- feat-processing, at see on mini-computer.

- Seel-time contouring with integration of
marigation data.

- Silaborated presentations: block-diagres, image
processing, colored maps.

At present time, the BDDO mas archived almost all the sea-beam data collected during Jean Charnot's cruitams, that memps about 1,000 days and 350,000 kilometers of profiles. This stock is reaused in a ampli book "Index dee Cuppages Sam-Ream du N/O Jean Charnot," index which will be soon com-line the COD's computer (Cantra Communications de Stategne) in Brant.

this takes on-line, the exploitation of data by image proceeding technics, the plot of colored maps, the automatic fitting of navigation with see-bose hathyeatry are our principal ways of development for

Induced Seismicity at the Fenton Hill Hot Dry Rock Site H, KEPPLER, C. PEARSON, J. ALBRIGHT, R. POTTER, F. HOMUIH (Earth and Space Sciences Division, Los Alamos National Laboratory, Los Alamos, AM 87545)

Mational Laboratory, tos Alamos, MH 87845)

Microearthquakes recorded during hydraulic fracturing experiments in EE-2, the injection well of the new deep Engineering Reservoir' (ER) at Fenton Mil. differ is twerel important whys from microearthquakes recorded in twe earlier "Reservoir" (RR) system. Unlike the RR where the fracture systems were generally vertical, the seven locations in the ER suggest a werite of en-echelon 45° disping fractures planes, which sprike signify well to sorth, similar to the RR fractures. This trend is quite well defined in the lower (4243-435) and depth) part of the ER, becoming more indistinct in the support (365-3527 m) interval. This change in fractures and indistinct in the support (365-3527 m) interval. This change in fractures represented and the definition compressive stress, perhaps first, these dipping fractures may important the orientation of the minimum compressive stress, perhaps associated with collapse of the nearby valles Caldera. A second dossibility is that these fractures may represent fault traces which were reactivated during the hydraulic fracturing experiment. This would mean that sweer failure occurs on the dipping fractures clanes. A second difference between induced saismicity in the RR and the R superiment, the beared microearthquakes had magnitudes of less than -2 and could only be detected using inscruments located in adjacent wellows when the surface. The fault planes collations of research quakes in the ER are still located using download instruments, the ER hydraulic fracturing experiments also cause relatively large events, with supintudes as a great as 1, which can us detected on the surface. The fault plane solutions of resea events are nearly included as in the surface. The fault plane solutions of resea events are nearly entired.

Deep Structure of Western Hediterranean Bagin : CROC 2 Large Aperture Spismic Survey

S. LE DOUARAM (Etif-Aquitains, Tour Générate, La Défente, Paria, Franço) J. BURPUS tinstitut Francais du Pétrals, 92500 Nusti-Malmaison, Tranço (Sponear : T. Bourbie) f. AVEDIF (Centre Océanologique de Breragne,

Oata from thirty one Expanding-Spread Profiles carried out in Gulf of Lign and Ligurian Sea in September 1981 were used to study deep structure of Messern Mediterranean Basin.

P-refractions and precritical reflections were observed even from the Moha despire presence of hallocinetic Messinian sait lever, and have been sed in the art domain to derive velocity structure used in the int gomain to getter velocity structure of both sedimentary cover and civilar, three different geological domains are distinct guished in this continental domains with a security billion to be and a thickness of 20 km, continued seawards or a structure continued the in the center of the basin, a double-takened crust, with secontines of 5.8 and a.7 km; and targit seconds of and the second control of the second c

ine tiguitan ara. Contribution of these data for Late oligocens

Volcanology, Geochemistry, and Petrol-

YBLA-15A Stable Isotope Compositions of Glasses from the Juan de Fuca Ridge

SASK, Canada

Slassy rims of sight pillow lawas dredged from the Juan de Fuca Ridge have 80 values that range from -84 to -64 perall. A positive correlation between the deuterium and water contents in most of the samples suggests that the range in 60 values is primarily the result of the addition of sewater to magnatic 30 values near -80 and water contents of 0.2 vt. percent. At least two of the samples have also lost CM, or M, because they are entitled in disterium but depicted in water relative to the magnatic values. All C values are also worldble (-44 to -12 peral) and the 1°C contents increase proportionately with the concentration of carbon in the plasses. Decreasing 1°C and carbon contents may be attributed to the differential loss of CO₂ which is enriched in 'C relative to the carbon dissolved in the glass. Although variations in the size and 80 values probably valuet the effect of the glasses indicate that anyeen factores probably reflect the isotopic composition of the source of the laws.

Evidence for multiple processes in the evalution of

cale-alkalina lavas from Santorini, Cyclades, Greece. J.P.P. HULJEMANS, H. BARTON and V.J.M. SALTERS (State University of Utrecht, Department of Geochemistry,

Budapestlase 4, 3508 TA Utracht, The Wetherlands)

nous material has played a role in the generic of the

The constancy of composition of the post-calders is-Seen with the altragenetic annually maps, the most ago, Pacific laves have been produced interpretently effecting being prominent east-west limitations.

Some filtered maps of the residual gravity have also during the last 2,100 years and equilibrium crystal. ego. Dagitic lavas have been produced intermittently lization is suggested as a possibility for the constancy of composition.

> Voicanic Ash "Clusters" in the Stratosphere After the El Chichon, Mexico, Eruption U.S CLANTON, Booding, J.L., and Blanchard, D.P. (MASA - Johnson Space Center, Code SM2, Houston, 11 77058)

On May 7, 1982; Project Airstream flow 8 cosmic dust collectors for 5 hrs. at altitudes of 17 to 20 km and over 30° to 49° % latitude and collected 2.4mg of ash from the April 4, El Chithon eruption cloud. Haterial occurred both as distrete shards and as composite "clusters" of shards. Individual shards ranged from .8

to 19.5 um in length. Long-axis measurements of 300 particles gave median, 7.5 µm; skewness, 0.497; kurtosis, 3.88. Reasurements of 484 clusters gave a range of 10 to 100 µm and a modian of about 30 µm. Calculations using Stokes' law imply that particless5 µm digreter should have settled bold 17km by the time of sample callection. Nowwer, calculations based on concurations using Stokes' law imply that particless's and dispeter should have settled below 17km by the time of sample collection. However, calculations based on the Kilson-Huang equations for tephra settling would be mill irregular particles up to -12 um maximum dimension to have remained at or above the collection ultitude. Heasured sizes of collected particles can be understood, in part, using the Wilson-Huang model but "cluster" formation may also be required to explain the magnitude of the size anomaly. Clusters form a fragile open irregular structure with an apparent effective ould density <1, much lower than the 2.5 g/cm² value which probably applies to individual shards. The fragile cluster structure indicates formation in the stratospheric abundance of 30 ng/m² (or, 200 particles/cm²) is calculated for the ask at the time of collection. The dimension of the modian particle is about 7.5 x 5.2 x 1.6 µm. A second collection in July, 126 days after the eruption, continued to show particulate material in the stratosphere. A third collection flight planned for October, will support a more detailed analysis of the abundance and composition of the ask in the stratosphere as a function of time and latitude.

M. BARTON and M. J. VAN BERCEN (Vening Meinesz Lab., Utracht, The Natherlands).

interaction between sold 'Tuscan' and potessic 'Roman'

maguas in the volcanic system of Mt. Amiata (Traly).

C.GREZZO and C.A.RICCI (latituto di Minaralogia a Patrografia, Siena, Ituly).

Rhyadecitic lavas from Mc.Asmiata volcanic complex (Southern Tuscany, Italy) contain abundant minette (mica and K-rich) inclusions. Najor and trace element data display continuous variation between the minute inclusions, some subordinets mail: latitic layer and the thyodacitic host lavas over a range of 48-672 510,. Al. Fe, Mg, Mg, Ca, Ti, P, Sr and Ba decrease with increasing Sio,, while Na and Li increase, and K,Rb,Zr,La,Ce,Nb

minette and latites are testurally and chamically identical to the phenocrysts in the rhyodacites. Patrographic mineralogical and chemical evidence indicates mages mixing, resulting from injection of mafic mages is the SiO2-richest rhyadacite from Mt. Amista, bolonging to the crustal anotactic Tuscon Province, whereas the mafic andmember has close affinities to the potassic alkaline taxes of subcrustol origin from the adjacent Roman Province.

Anelysts of B-Type Carebquakes and Explosions at Paviof

5. MCHYT

J. 1987 (Lemont-Doherty Gaological Observatory
Depresent of Gaological Sciences of ColuVaivardity, Falisades, New York 10764)

Maivereiry, Felinades, New York 10964)

An aight-station natwork of short-parind smismosters has been spectied man Pavlof Volcano, (75°25°7, 161°34°4) Alacka Paninsula airca 1876. Kigh quality acaing to digital and direct digital data were recorded during steptions in 1860 and 1881. We amalyzed data from apploafons with distinct air phases and from systematic actingular (shallow), ico-frequency sweets lacking clear 5-phases) to determine source and propagation affacts. Saturan sero and several hundred systems are day are recorded, with higher numbers during systiams. Nagnitudes range between -0.2 and 1.0, and b-values range between 1.9 10.1 and 2.4 ft.1.

Five rasults are most important: 1) Data from savel latatics are most important: 1) Data from recorded ailiptical particle motion are moved dispersion, and are have probably Rayleigh waves; 2) Stating of the events schances the F-wave, which has a welocity of 2.2 z 0.3 km/sar; 3) The explosions and Actype events here similar hyperanters, as evidenced by affant characteristics and west errors times, 4) The Pripe avents are similar hyperanters, as evidenced by amancy, sween allowing for actionators affects. In particular, a well-defined P-wavelet at one argifum has a forted greater than one accord, nuggesting a service source-time function; 5) The volcane announced the source-time function; 5) The volcane announced attenuation in its shallow structure.

<u> Classified</u>

and Y are virtually constant. Xpnocrysta present in the

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Reflection Seismologist. Recent PhD in reflection seismology looking for a research associate position. State-of-the-art knowledge of wave propagation, data processing, and computer graphics. Send replies to Box 015, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C., 20000.

Hydrologist Seeks Consulting/Research/Teaching Position. MS (Irrigation Eng), PhD (Ag. Eng). Three years experience in computer model applications in hydrology and data processing. Box 016, American Geophysical Union, 2000 Florida Avenue N.W., Washington DC 20009.

POSITIONS AVAILABLE Assistant Research Oceanographer/SIO. The Ocean Research Division of Scripps Institution of Oceanography invites physical oceanographers to apply for a position as Assistant Research Oceanographer, the research equivalent of Assistant Professor (Ph.D. in physical sciences or equivalent degree required). Candidate must have strong background in applied mathematics and fluid dynamics; strong interest in ocean dynamics; and proven presearch interest in ocean dynamics; and proven research and publication record in physical oceanography

This position is funded through ONR contract for two years. Appointment beyond two years is contin-gent on candidate obtaining extrantital support. It is expected that the majority of research effort dur-ing the two years will be devoted to the theory and analysis of data on Kuroshio variability. Salars range is \$22,000-\$26,000 commensurate on qualiti-cations. Position start date is approximately 4/1/83. Please send resume and at least three references to Dr. Russ Davis, Chairman, of Ocean Research Division A030, Scripps Institution of Oceanography (E. La Jolla, CA 92093 by March 15, 1983, For additional information about the position contact by Peter Niler (019) 452-4100. The University of Colifornia, San biego is an Equal Opportunity/Affirmative Ac-

Physical Oceanographer/Oregon State University. Assistant or Associate Professor, depending on experience. Applicants may be observationalists or theoreticians but must have a Ph.D. in the physical control of the physical theoreticians but must have a 1th.D. In the physical sciences, have demonstrated the ability to conduct independent high-quality research and are expected to obtain research funding. Duties include reaching and supervision of graduate students. Interested candidates should submit a resume and names of three references by 1 March 1993 to: C. Ross Heath, Dean, School of Oceanography. Oregon State University, Corvallis, OR 97331.

Affirmative Action/Equal Opportunity Employer.

Faculty Teaching and Research Position/Institute of Marine Science, University of Alaska, Fairbanks. Research interests should include the numerical modeling of estuarine, coastal and open ocean physical oceanography in subpolar or polar environments. Participation in interdisciplinary studies is appropriated. ocean physical oceanography in subpolar or polar environments. Participation in interdisciplinary studies is encouraged. Applicant should have an extensive background in hydrodynamics and numerical modeling. Ph.D. degree in physical oceanography is preferred (or its equivalent in training or experience). Rank and salary will be determined by experience. Candidates should send resume and names of three referees to: Dr. Vera Alexander, Director, Institute of Marine Science, University of Alaska, 99701. Closing Date March 15, 1983. The University of Alaska is an EOAA Employer and Educational Institution.

Your application for employment with the U of A may be subject to public disclosure if you are selected as a finalist.

MIT FACULTY **POST IN ACOUSTICS**

The Department of Ocean Engineering invites applications for a faculty position in acoustics, at either the Assistant or Associate Professor level, effective September 1, 1983. Teaching responsibilities will include graduate education in acoustics and participation in related programs in polar engineering, marine sensing and information ems engineering, or underwater systems dynamics. Research will involve experiments at sea, including work in the Arctic Ocean, laboratory efforts, analysis of computer-based data, analysis and modeling, and/or theory building.

Candidates should have an advanced degree, preferably a doctorate in acoustics or closely related field. Research experience in one or more of the following essential: propagation of sound in the ocean, both theoretical and experimental; acoustic scattering processes in the ocean; ambient noise mechanisms; behavior of sound in ice-covered waters; communication, information, and sensing systems; ship noise radiation and control: flow noise.

Candidates should submit complete resume or curriculum vitae along with list of professional references, and reprints of two papers representing work in acoustics. Closing date for applications is April 1, 1983. Application materials should be sent to Prof. Ira Dyer, Chairman of Search Committee, Massachusetts Institute of Technology, Rm. 5-212, 77 Massachusetts Avenue, Cambridge, MA 02139. MIT is an equal opportunity/affirmative action employer.

Naval Postgraduate School. The Department of Oceanography invites applications for the position of Adjunct Research Professor in the Ocean Turbulence Laboratory. The successful applicant will be responsible for the organization and execution of oceanic turbulence measurements as well as the interpretation and reporting of the phained data. The position requires a Ph.D. or equivalent in Physical Oceanography, 8 years of post-doctoral experience with oceanic measurements and data interpreical Oceanography, 8 years of post-doctoral experience with oceanic measurements and data interpretation, and some familiarity with turbulence instrumentation. The Ocean Turbulence Laboratory is actively engaged in the measurement and interpretation of oceanic turbulence data from a variety of environments obtained with several type of vehicles. The successful candidate will be expected to contribute to the growth and development of the scope of the research performed by the laboratory.

Applicants should send a resume, statement of tescarch record and interests, and the names of at least three references to, Prof. Thomas R. Osborn, Code 680r, Naval Postgraduate School, Monterey, CA 93940.

Applications will be considered until Murch 8,

CA 93940.

Applications will be considered until Murch 8, 1983. Applicants should provide a curriculum vitac. three professional references, and a statement of professional (research and instructional) goals. Send letters of application to: Professor Christopher N. K. Mouers, Chaitman, Department of Oceanography, Naval Postgraduate School, Monterey, CA 93940. Phone: (408) 046-3552/353.

Research Associate/Upper Atmospheric Physics. The National Research Council (Canada) is building a multi-instrument ground based research facility called CANOPUS. One part of CANOPUS is a thata Analysis Network which will provide Interactive access to the CANOPUS data by scientists across Canada. A research associate position exists for a person who would be associated with implementing and operating this network. This position will allow some independent research on aspects of the CANOPUS data and the holder of the position would be encouraged to nuclertake such research.

CANOPUS data and the holder of the position would be encouraged to undertake such research. The position requires a Ph.D. in some aspect of upper atmospheric physics (preferably ground based) and extensive computer experience. Any related experience in computer networking, etc. would be an advantage. The initial salary will be in the range from \$24,000 to \$27,000 per year, depending on experience. The appointment will be initially made for two years and commences as soon as possible.

as possible. Send resumes and the names of three referees to:

Professor J. A. Kochler Institute of Space and Atmospheric Studies University of Saskatchewan Saskatoon, Saskatchewan S7N 0WG

Assistant Professor/University of Alberta. The Department of Physics at the University of Alberta invites applications for a tenure track position at the level of an Assistant Professor in Physics in any of

level of an Assistant Professor in Physics in any of the following areas:

1. Astrophysics and Astronomy;

2. Geophysics (Electromagnetic methods);

3. Theoretical Physics (Medium Energy, Parti-cle Physics, Relativity and Cosmology).

The 1982/83 salary range for an Assistant Profes-sor is \$27.720-\$39.820 per anatum.

Applications will be received until Mas 1, 1983, and the expected appointment date is july 1, 1983.

The Department of Physics offers both under-graduate and graduate degrees in Physics and Gen.

graduate and graduate degrees in Physics and Geo-physics: The Department currontly communated Z.— Faculty Members, 90 Research Associates and Post-Ductoral Fellows and 50 Graduate Students. Candidates interested in applying should submit a curriculum vitae plus the names of three (3) refer-

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Department of Physics

University of Alberta

Edmonton, Alberta, Canada

T66 211

The University of Alberta is an equal opportunity employer but, in accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

University of Kentucky/Department of Geology. The Department of Geology invites applications for two tenured track Assistant Professor level positions. Both appointments are for soft rock geologists preferably with some experience in industry and interests including one of the following: sedimentology, stratigraphy, carbonate petrology, organic geochemistry, or isotope geology. The successful applicants would be required to participate in active research, supervise graduate students and teach graduates and undergraduates. Familiarity with quantitative techniques is desired; Department has access to a variety of computational devices. Academic vitae and names of three references should be sent to Dr. Lyle Sendlein, Chairman, Search Committee, 32! Patterson Office Tower, University of Kentucky, Lexington, Kenucky 40506-0027. Closing date is March 1, 1983. Both appointments are to commence in August 1983, but an earlier date may be considered. Salary is negotiable.

The University of Kentucky is an equal opportunity/affirmative action employer.

Virginia Polytechnic Institute and State University/Structural Geologist. The Department of Geological Sciences invites applications for a tenuretrack position in Structural Geology at the Assistant or Associate Professor level. The position involves teathing at the graduate and undergraduate level and supervision of graduate suslent research. Candidates should be process-oriented with interest infield related problems. A Ph.D. and strong research potential are required. Closing date for applications is April 15. The position is available from September 1, 1983.

ber 1. 1983.

To apply send a vita with list of publications, summary of present and proposed research and the names of three references to: Kenneth A. Eriksson, Chairman of Search Committee, Department of Geological Sciences, VPI & SU, Blacksburg, VA

Affirmative Action/Equal Opportunity Employer

Paculty Position/CSM. The Departments of Geology and Geophysics at Colorado School of Mines attribute an opening for a join suppointment as Professor of Geology and Geophysics to commence September 1, 1983.

The successful applicant will be expected to teach courses and conduct research integrating exploration geophysics with petroleum geology. Applicant should possess the Ph.D. degree and responsible experience in exploration research and traching. A resume and references should be forwarded to Dr. George V. Seller, Headt Geology Department or to ment. Colorado School of Mines; Gelden, Colorado 80401. Closing date for applications is April 15. Colorado School of Mines; Gelden, Colorado 1983.

1983.
Coloradin School of Mines is an Affirmative Action Equal Opportunity Employer.

Marine Geology & Geophysics

Woods Hole Oceanographic Institution invites applications from researchers active in the fields of marine geology and geophysics to fill available positions on the scientific staff of the Department of Geology & Geophysics. We seek applicants at a broad range of experience levels, from immediately postdoctoral to those with ten or more years' of industrial or academic research experience. Our intention is to strengthen over the next year the department's active earth sciences program by making staff appointments in marine geology and geophysics.

The Institution offers excellent facilities to carry out the full spectrum of practical and theoretical marine earth science research. A strong interest by candidates in conducting seagoing programs is preferred and a capability to conceive, fund and carry out independent research programs is required. In addition to Geology and Geophysics, the Institution consists of four well-estab ished research departments specializing in the fields of Biology, Chemistry, Physical Oceanography, and Ocean Engineering. Collabora tive research with the members of staff of these departments is strongly encouraged. Opportunities also exist for participation in the joint Massachusetta Institute of Technology - Woods Hols Ocsanographic Institution graduate level education program.

Applicants should send resumes and names of three professional references to:

Personnel Manager Box 54P



Woods Hole Oceanographic Institution

Woods Hole, MA 02548 n squal opportunity employer M. F. H__

The Pennsylvania State University/Faculty Positions. The Department of Geosciences invites applications for three (3) tenure track faculty positions, which are expected to remain open until filled by outstanding geoscientists in any of several fields of specialization. The faculty rank associated with each position is presently open, although salary funds currently available are sufficient for at most one senior full professorship. Salaries, which are competitive, will be commensurate with the experience and qualifications of the appointees. The successful candidates must be, or have demonstrated the potential to become, nationally recognized leaders in their fields. They must also have an interest in their fields. They must also have an interest in teaching and advising graduate and undergraduate students. Persons having an interest in collaborative research with other department faculty are preferred. Instructional and research areas in which particular needs have been identified include, but are not necessarily limited to: aqueous geothemistry, with emphasis on low-temperature rock-water (groundwater) interactions; heavy isotopeltrace element geothemistry, with emphasis on global geophysical and geological professors and observable manifestations; tectonics, with emphasis on global geophysical and geological professors and observable manifestations of them; sedimentary geochemistry, with emphasis on quantitative aspects of carbonate petrology or clay mineralogy; X-ray mineralogy, with emphasis on pet-

THEORETICAL OR EXPERIMENTAL SPACE PLASMA **PHYSICISTS**

NASA-MARSHALL SPACE FLIGHT CENTER Huntsville, Alabama 35812

Two positions in theoretical or experimental space plasma physics are available in the Magnetospheric Physics Branch of the Space Science Laboratory at NASA's Marshall Space Flight Center. Either theoretical or experimental backgrounds will be considered with a preference given to theoretically oriented researchers to complement the extensive experimental activities of the branch. The Magnetospheric Physics Branch is involved in the analysis of lowenergy plasma data from the ISEE, SCATHA, and Dynamics Explorer satellites, from sounding rockets, and from the Space Shuttle (STS-3). In addition, the group is presently carrying out the joint development of a variety of active space plasma experiments that will be flown on Spacelab One, Two, and Six.

Salaries range from \$34,930 to \$41,277 per annum, depending on experience.

Interested applicants may contact Dr. Charles R. Chappell at the Marshall Space Flight Center (205-453-3036). Forward resumes to the following address not later than March 1, 1983:

> NASA-Marshall Space Flight Center Space Science Laboratory

Attn: Dr. Charles R. Chappell, ES51-R2 Huntsville, AL 35812

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rulogical applications of crystallochemical methods; and modeling of dynamical earth processes using ap-propriate physical and mahematical representa-

tions.

The selection of persons to full these three posinons will be based in part on the extent to which
their future research efforts will complement and
further strengthen our programs in Grenhemistry
and Mineralogy, Geology, and Geophysics, Qualified persons should, therefore, include a brief description of their future research objectives with
their resumes and the names of three references,
and send to:

nd send to:

C. Wayne Burnham, Head
Department of Geoschemes
The Pennsylvania State University
503-B Deike Building
University Park, PA 16802.
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Organic Geochemias/The Skidaway Institute of Oceanography. Invites applications for a full-time research position at the position to the position for a full-time research position at the position to the successful candidate will be expected to design and conduct research related to understanding the organic geochemistry of near-shore marine sediment and how chemical/hiological processes in these sediments influence the form and availability of compounds and elements. The position will be available on or after July 1, 1983 with a deadline for application of April 1, 1983, Requirements include the attainment of a Ph.D. degree or

equivalent research experience. Application mass made by submitting a resume, a statement of re-search interests and the names of loar individuals who can be contacted for reference purposes to:
Director Director
Skidaway Institute of Oceanography
P.O. Hoy 13687
Savanniah, GA 31410
The Skidaway Institute of Oceanography is an
equal opportunity/afficinative action employer.

Position in Petrology/Rice University, Houston, Texas. The Department of Geology has a tenue-track opening beginning July 1985 with stating re-el-of appointment depending on the experience of the emolithete. The faculty member is expected to establish, or continue a vigorous research program in petrology, and to participate in teaching in manadogy-petrology. Research meas in which we are petentially interested includes Igneous petrology, metamorphic petrology, ore disposition, experimental petrology, interactions of finds with rocks and settliments, isotope geochemistry, but other specialities are not excludent from consideration. Available research lacibilities of the Department include: electron-incroprobe, ICP-spectrograph, Ar-Ar dating, and stuble light isotope mass-spectrometry. Send curriculum viace, a statement of planned research, and names of at least three references to Dr. A. W. Bally, Chairman, Department of Geology, Rice University, P.O. Box 1892, Houston, Texas 77231.

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NRL

NAVAL RESEARCH LABORATORY PLASMA PHYSICS DIVISION Supervisory Research Physicist GM-1310-15 \$48,553 to \$63,115 per annum

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As Branch Head of the Geophysical and Plasma Dynamics Branch, which employs 15 scientific and support personnel, manages, supervises and conducts research for a broad theoretical and numerical simulation program in almospheric, lonospheric, magneto-spheric phenomena of interest to the Department of Defense, Research emphasizes the solution of problems in high altitude nuclear effects (HANE)

The state of the state of

and the development of models describing atmospheric, lonospheric, and magnetospheric phenomena. Problems of particular interest are; ionospheric irregularities at high equatorial latitude; magnetic field reconnection processes; 2D and 3D MHD global magnetospheric modeling; auroral field line modeling; anomalous resistivity; lower hybrid drift and tearing mode

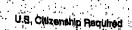
instabilities: ELF/VLF generation;

and gravity wave breaking in the

Qualifications: A Bachelors or higher degree in physics (Ph.D. preferred) plus at least 3 years of professional experience in or directly related to the duties described above with one year equivalent to GS-14.

Please submit your comprehensive resume or SF-171 and publication list by 15 March 1983 to:

NAVAL RESEARCH LABORATORY ORD CIVILIAN PERSONNEL OFFICE Attn: 47-80-13.1 KMO/EOS 4555 Overlook Avenue, S.W., Washington, D.C. 20375



DATA PROCESSING

Scientific Systems Analyst Denver, Colorado

Sohio's Exploration computing staff has a major challenge for a talented individual in Systems Design. We need to combine data from several data bases into a functioning interactive program that our Geologist and Geophysicist users can use to efficiently explore for oil and gas in the vast Rocky Mountain Area.

Several important problems need to be analyzed and solved to achieve our goal of accurate maps. Challenging problems of data flow, plotting, and graphics display will test the limits of your abilities.

We require a specific background that includes 4 years of programming in FORTRAN with extensive use of plotting equipment and graphics display. Work/academic experiences with interactive data bases and/or oil and gas applications would be very helpful. A Bachelor's or advanced degree in Computer Science, Mathematics, Engineering, or Earth Sciences is a definite plus. We run VAX 11/780 so any DEC experience will be positively viewed.

In addition to being a part of a successful enterprise, you will qualify for a compensation package including a highly competitive salary and excellent employee benefits. Qualified individuals will have access to our transfer policy which offers new hires many features that other firms reserve only for transferring executives. Please respond by sending a detailed resume to H.R., Sohio Petroleum Company, R7171, 633 17th St., Suite 2200, Denver, CO 80202. Preference will be given to resumes sent by individuals while those referred by employment agencies will be held for later review.



An equal opportunity employer M/F/H/V.

Faculty Positions/The University of Iows. The Department of Physics and Astronomy anticipates one or two openings for tenure-track assistant professors or visuing professors of any rank in August 1983. Preference will be given to experimentalists in any area for the tenure-track positions. Cutrent tesearch interests include astronomy, atomic, condensed matter, elementary particle, laser, nuclear, plasma, and space physics. The positions involve undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a résumé and a statement of research interests, and have three letters of recommendation sent to Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 32242.

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ammative action employer.

Geophysicists/Institute for Geophysics, University of Texas at Austin. Applications are invited for research scientists with a Ph.D. in the general areas of marine geophysics or theoretical seismology. We are particularly interested in innovative individuals who wish to pursue a career primarily in research with some teaching and graduate student responsibilities. The Institute is located in Austin and operates closely with the Department of Ceological Sciences of the University. It is a vigorous and growing group with interests in both land and marine geophysics. Research facilities include a 167' ship equipped with state-of-the-art multichannel and high resolution selsmic reflection and OBS selsmic refraction capabilities.

Applicants should have a demonstrated ability to

Applicants should have a demonstrated ability to do creative research. Both midcareer and recent Ph.D.s are encouraged to apply. Applicants should submit resume, the names of at least three references and a statement of research plans and priorities to:

A. E. Maxwell, Director
Institute of Geophysics
University of Texas at Austin
Austin, TX 78712.
While late applicants will be considered, we prefer
to have applications in hand by April 15, 1983.
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affirmative action employer.

affirmative action employer.

Postdoctoral Position in Laboratory Astrophysics. The Center for Astrophysics and Space Sciences of the University of California, San Diego is seeking a Postgraduate Research Physicist beginning carly 1983. The primary research area will be interstellar dust grains, with emphasis on their formation, mantle growth and composition, and their role in nolecule formation. Both laboratory simulation of interstellar conditions and a theoretical approach will be pursued to extend an ongoing experiment on the properties of grain mantle analogs. The applicant should have experience in laboratory practices including infrared spectroscopy, cryogenics and vacuum techniques mass spectroscopy, etc. and also some experience in computing. The research group has a large body of data on IR astronomical spectra and several ongoing observational and theoretical programs in astrophysics which can provide backup information to the dust grain research. Candidates should have completed a Ph.D. in astrophysics or related field before the end of 1982. Salary is in the range \$18,152 to \$19,848 depending on qualifications and experience. Please send your curriculum vitae, including the names of 3 references, your issent interests to Dr. B. Jones, Center for Astrophysics and Space Sciences, C-011, University of California San Diego, La Jolla, CA 92095 by February 28, 1985.

The University of California is an Equal Opportunity/Affirmative Action Employer.

Marine Geophysicist/Texas A&M University. The Department of Oceanography of Texas A&M University will have an opening for a tenure track faculty member in Marine Geophysics beginning September 1983. Preference will be given to candidates with a strong quantitative background in a wide range of geophysical topics and who have both interest and experience in marine exploration.

The successful applicant will be expected to teach undergraduate and graduate courses and to conduct a vigorous research program in his or her specialty. The position is to be filled at the level of Assistant Professor. A Ph.D. is required for this position. Salary is negotiable depending upon experience and qualifications.

Applicants should fauthuit a vita along with a letter describing his/her research and teaching goals and names of five persons for reference to Professor R. O. Reid, Head, Department of Oceanography, Texas A&M University, College Station, TX 77843. The closing date for applications is March 15, 1983. Texas A&M University is an affirmative action/equal opportunity employer.

Marine Sciences Research Center SUNY Stony Brook/Tenure Track Faculty Position Chemical Oceanography/Marine Geochemistry. We have a opening for an assistant or associate professor of opening for an assistant or associate professor of marine chemistry, chemical oceanography, or marine geochemistry for September 1983. Candidates should hold a Ph.D. in an appropriate field and have their major research interests in coastal marine environments, By I March 1983 send a complete resume and have at least three letters of reference sent directly to: Chair, Chemistry Search Committee, Marine Sciences Research Center, SUNY Stony Brook, Stony Brook, NY 11794. SUNY Stony Brook is an equal opportunity/affirmative action employer. AR # \$23.

Paleogeologist

Staff position available immediately for Paleogeologist with strong computer background for a data analysis project in an environmental sciences program. Some experience in petroleum geology would be useful. The appointee will have the opportunity to be involved in a general geoscience research program. Salary and conditions of appointment will be commensurate with the qualifications of the appointee.

Candidates should submit a curriou-ium vitas, including statement of re-search interests and the names of three professional references to: Mr. Bernard Manowitz, Chairman, Depart-ment of Energy & Environment, Brockhaven National Laboratory, As-sociated Universities; Inc., Upton, L.I., New York 11973, eoe/mf

Brookhaven National Laboratory Associated Universities Inc.

Memphis State University/Faculty Position in Geophysics or Geomorphology/Remote Sensing. The Department of Geology invites applications for an anticipated tenure track position starting September 1985. Besides normal departmental duties, the successful candidate in geophysics will be expected to cooperate with our active affiliate institute, the Tennessee Earthquake Information Genter (TEIC). The department and TEIC want to augment their strength in solid earth geophysics with an addition in exploration geophysics. Preference will be given to geomorphology candidates whose interests combine geomorphology and tectonic processes.

Applicants should submit a letter or application, resume and name/address/phone number of three references to: Phili Deboo, Chairman, Department of Geology, Memphis State University, Memphis, TN 88152.

Atmospheric Chemistry & Aeronomy Division (ACAD) and Scientist I or II. The National Center for Atmospheric Research in Boulder, CO is seeking a scientist I or II. The National Center for Atmospheric Research in Boulder, CO is seeking a scientist to establish and martage the scientific research in Incoherent Scatter Radar data base. Will interact with user and radar community to establish research project to insure appropriate scientific use of data base. Position requirements include Ph.D. degree or equivalent, research experience in aeronomy physics, electronic engineering, atmospheric science, or closely related field. Familiarity with the Intoherent Scatter Radar techniques for measuring the properties of the ionosphere, magnetosphere, and atmosphere. Demonstrated high level of skills in advanced FORTRAN programming, numerical modeling data reduction techniques, (level III) requires national scientific recognition and demonstrated leadership skills in and promoting Incoherent Scatter Radar research. This is a term position subject to annual teview and continued funding for project. Send testine PROMPTLY to Esther Blazon, NCAR, P.O. Box 3000, Boulder, CO 80307 or call 303-194-5151 ext. 581 got information.

NCAR is an equal opportunity/affirmative action employer.

Iowa State University of Science and Technology, Department of Earth Sciences/Faculty Positions. Applications are invited for a tenure-track faculty position in mineral resources. Rank is at the assistant or associate professor level, dependent upon qualifications. The successful applicant will be expected to develop a strong research and graduate student program in mineral resources/economic geology and will teach undergraduate and graduate courses in this subject. An applied field orientation is preferred.

is preferred.

Towa State has enablished a Mining and Mineral Resources Research Institute in order to support and develop research and education in mineral resources. An interdenanticular architecture. and reverop research and education in triblerar re-sources. An interdepartmental graduate minor in Mineral Resources has also been established. In addi-tion to the appointment in the Department of Earth Sciences, there will be bull opportunities to interact

Sciences, there will be full opportunities to interact with these programs.

Completion of the Ph.D. prior to appointment is strongly preferred. In addition, research ability shown by other publications and/or powdotroral in industrial experience will be an advantage. The position is currently available and is expected to begin no later than September 1983, For application information, please write to:

Bert E. Nordlie, Charrman
Department of Larth Sciences
253 Suchee I

Iowa State University Ames, Iowa 50011 lowa State University is an equal opportunity af-

Research Positions/Lunar and Planetary Laboratory. The Lunar and Planetary Laboratory at the University of Arizona has research positions open for Planetary Scientists, with Planetary Astronomy and Planetary Scientists, with Planetary Astronomy and Planetary Geology being areas of greatest interest to the Laboratory at this time. Researchers at the Laboratory have access to the University's observatories, a wide range of astronomical instrumentation, a complete collection of planetary images, computers and laboratory facilities. The research ranks in the Laboratory, namely Assistant Planetary Scientist, Associate Planetary Scientist, Associate Planetary Scientist, and Planetary Scientist, and Planetary Scientist, and Planetary Scientist level in making appointments at the Assistant or Associate Planetary Scientist level. These are not tenurable and not state-funded positions. Salary levels are commensurate with equivalent tenure-track ranks. Researchers in these positions will be expected to supply a significant portion of all of their salaries through their grants and contracts.

Applicants should submit a curriculum vita, list of publications, and the names of three references by April 30, 1985, to L. L. Wilkening, Director, Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona, 85721.

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Franklin and Marshall College/Petrologist. We have a 1-year position for the 1983-84 academic year with the possibility that the position may be extended for 1 additional year. The position is full-time involving up to 12 contact hours/semester. Candidates would teach petrology (a one-semester combined igneous and metamorphic course) and either economic geology or a course in their specialty. Candidates would also teach introductory physical geology once a year. Completion of Ph.D. prior to appointment is preferred but not essential. Franklin sud Marshall College has an active geology department which consists of 7 full-time staff members and graduates 25 majors per year. Teaching and research full time are excellent including an

members and graduates 25 majors per year. Teaching and research facilities are excellent including an automated XRF vacuum spectrometer. The college is a small (2000 students) four year liberal arts insti-

tution.
Candidates should send resume and arrange for 3 letters of reference and transcripts to be sent to:
Dr. Stanley A. Mertzman, Chairman
Department of Geology
Franklin and Marshall College
P.O. Box 5003

P.O. Box 3003 Lancaster, PA 17604. Franklin and Marshall College is an equal oppor-

Isotope Geologist/University of Wyoming. The Department of Geology/Geophysics invites applications for a tenure track position at the assistant professor level in hotope geology. The applicant's field of specialty may be stable or radiogenic isotopes. The successful candidate will be expected to teach undergraduate and graduate courses and conduct his/her own research program.

Current research in the University of Wyoming includes: crustal evolution in the Archeun and Proterozoic; the systematics of magina contamination; carbonate diagenesis; fluid-rock interaction; and the tectonic evolution of compressional and extensional orogenic belts. We hope the successful candidate will complement these studies as well as develop a strong, independent program. Applicants should submit a vita, transcripts, a letter describing future research inforests, and names of three references to Dr. Robert S. Housson, Head, Dept. of Geology/Geophysics, PQ Box 5006, University Station, University of Wyoming; Laranie, WY 88071. Closing date for applications is February 28, 1983;

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AMOCO Foundation Ph.D. Fellowship

Department of Geology University of Missouri-Columbia

The Department of Geology invites applications for the Amoco Foundation Fellowship to support an outstanding Ph.D. Candidate in any subdiscipline of geology. This 3-year fellowship includes a generous stipend, walver of tuition and fees, and substantial funding to support research. The Department of Geology has dynamic research programs in sedimentology, sedimentary petrology, low temperature geochemistry, tectonics, geophysics, paleontology, and igneous and metamorphic petrolo-

For application materials and additional information contact:

Director of Graduate Studies Department of Geology University of Missouri-Columbia Columbia, MO 65211 The deadline for application is March 1, 1983.

Assistant or Associate Professor/CSM. The Geology Department of the Colorado School of Mines invites applications for a faculty position commencing September 1, 1983 as Assistant or Associate Professor vites applications for a faculty position commencing September 1, 1983 as Assistant or Associate Professor of Geology in the specialty of Paleontology and Sedimentary Geology to teach rourses at the undergraduate and graduate levels, direct theses and conduct research in these areas. The Ph.D. degree is required. Salary is dependent upon experience. The deadline for applications is April 15, 1983. Resumes and references should be mailed to: Dr. J. J. Finney: Head, Geology Department: Colorado School of Mines; Golden, Colorado 80401.

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Vincent C. Kelley and Leon T. Silver Graduate Fellowships

DEPARTMENT OF GEOLOGY THE UNIVERSITY OF NEW MEXICO

The Department of Geology of the University of New Mexico Invites applications for the Vincent C. Kelley and Leon T. Silver Graduate Fellow ships. The fellowships will be awarded on the basis of the scholastic record and academic promise of graduate applicants. Each fellowship vill provide for a generous living sti pend of \$1,000/month for 9 to 1 months, and up to \$2,000/year fo travel and research expenses. The Caswell Silver Foundation will pay all tuition and university fees. The awards are made on an annual basis. but may be renewed for up to three years for those individuals in the masiers program, and up to live years for those individuals completing both M.S. and Ph.D. degree requirements A M.S. thesis may be used as a basis for Ph.D. program. Preference will be given to; but is not restricted to apclicants for the Ph.D. program.

An application for admission to the JNM Graduate Program, transcript Graduate Record Exam results (verbal, math and geology), three letters of reference and a brief statement of research goals are required for con-sideration for the fallowships. Ap-plication materials may be obtained from:

Rodney C, Ewing Chairman Department of Geology University of New Mexico Albuquerque, New Mexico 87131



The deadline for applications is larch 1, 1983 for the Fall semester of 1983.